URBAN RAIL SYSTEMS:
A PLANNING FRAMEWORK TO INCREASE THEIR SUCCESS

by

Ela Babalik

A thesis submitted to the University of London
for the degree of Doctor of Philosophy

Centre for Transport Studies
University College London

August 2000

ABSTRACT

Since the 1970s, there has been a significant increase in urban rail investment. 139 new urban rail systems, metros and light rail systems, have been built world-wide in the past three decades. These investments were in general planned as instruments to solve transport and land-use problems associated with the extensive use of the car. Very few have been successful in improving transport and the urban environment. Previous research has shown that while most of the new generation urban rail systems have not been very successful, their success could have been enhanced if the co-ordination between transport planning and urban planning had been stronger. However, co-ordination is very difficult to achieve within the contemporary local government structure and fragmented planning system. In spite of these findings, political support for urban rail systems is still strong, and investment on these systems is very likely to continue. Considering the cost incurred in the development of these systems, to make them successful remains a challenge.

This study explores ways of making new urban rail systems more successful. It develops a methodology for analysing the success of systems, identifying the factors behind their success, and enhancing their success. Based on the analysis of new generation urban rail systems, a planning framework is developed. The framework is a policy-based approach to help planners and operators to increase the success of their systems. It has two main functions: it predicts the success of new systems, and makes recommendations on how their success can be enhanced. While the framework addresses many factors that may affect success, there is a special focus on exploring methods for providing and sustaining co-ordination between transport and urban planning.

The planning framework is developed through the analysis of eight case studies, four from the United States, one from Canada, and three from Britain. It is then tested on seven other urban rail systems, five from the United States, one from Canada, and one from France. Finally, the framework is applied to recently opened urban rail systems in Britain and Turkey: it predicts how successful these systems are likely to be, and shows how their success can be enhanced.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Prof. Roger L. Mackett, for his help, guidance and encouragement throughout the research.

I also thank Dr Nick Tyler, my second supervisor, for his advice and for the helpful discussions we had during the course of the research.

I would like to acknowledge the Middle East Technical University in Ankara, Turkey, who funded my study and stay in London.

I gratefully acknowledge the funding by the Brian Large Trust as a contribution to the study trip to North America made in June 1997. I also acknowledge the University College London Graduate School for its contribution to the North America study trip as well as to the study trips to Sheffield and Newcastle Upon Tyne, Britain.

I would like to acknowledge the assistance of various experts working for the transport agencies, municipalities, and other local government organisations in Miami, St Louis, San Diego, Sacramento, Atlanta, Baltimore, Portland, San Jose, and Los Angeles in the United States; Vancouver and Calgary in Canada; Rouen in France, and Newcastle upon Tyne, Manchester, Sheffield, Birmingham, and Croydon in Britain. These organisations are: MetroDade Transit Agency, and Metropolitan Dade County-Planning Department in Miami; Bi-State Development Agency, East-West Gateway Co-ordinating Council, Citizens for Modern Transit, and Regional Commerce and Growth Association in St Louis; Metropolitan Transit Development Board, SANDAG (San Diego Association of Governments), and City of San Diego in San Diego; Sacramento Regional Transit District, Sacramento Area Council of Governments, City of Sacramento, and Capitol Area Development Authority in Sacramento; Metropolitan Atlanta Rapid Transit Authority in Atlanta; Mass Transit Administration in Baltimore; TRI-MET in Portland; Valley Transportation Authority in Santa Clara; Metropolitan Transportation Authority in Los Angeles; British Columbia Rapid Transit Company Ltd., BC Transit, Greater Vancouver Regional District, City of Vancouver, City of Burnaby, and City of Surrey in

Vancouver; Calgary Transit in Calgary; Metrobus Transports en Commun de l'Agglomération Rouennaise in Rouen; Newcastle City Council and Nexus the Passenger Transport Executive in Tyne and Wear; Greater Manchester Passenger Transport Executive (GMPTE) and Manchester City Council in Manchester; South Yorkshire Passenger Transport Executive (SYPTE), Supertram Ltd., and Sheffield City Council in Sheffield; West Midlands Passenger Transport executive (WMPTE) in Birmingham; Croydon City Council in London; and EGO, the transport department of the Greater Ankara Municipality, in Ankara. In addition, the technical assistance of Tom Parkinson, president of Transport Consulting Limited, Vancouver; Jon Willis, London Transport, London; Tony Young, former operational planning manager, GMPTE; John Keyworth, former Director of Planning, Sheffield Development Corporation (SDC); Patsy Healey, Simon Raybould, and John Nelson, University of Newcastle; Russ Haywood, Sheffield Hallam University; Prof. Güngör Evren, Istanbul Technical University; and Prof. Ali Türel, Middle East Technical University are gratefully acknowledged. However, none of these organisations or people are responsible for the views or interpretations expressed throughout the research, for which the author takes responsibility.

I would like to thank all members of the Centre for Transport Studies for their support and assistance.

Technical assistance of Simon Williams, UCL Language Centre, in correcting the language of parts of the work, is also gratefully acknowledged.

I thank Ricardo Marar, Silvia Costa, Paulo Silva, Martha Caiaffa, Ming Tsai, and Didem Kilickiran for their support and friendship.

I would also like to thank Colin Sutcliffe for his support, encouragement and understanding during the course of this work.

Finally, I would like to thank my family, Naciye, Muhip, and Ece Babalik, for their love and support. This thesis is dedicated to them.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

In the past three decades, there has been a significant increase in urban rail investment. Metros and particularly light rail systems have become very popular with planners and politicians world-wide. Many cities, ranging from large metropolitan areas to small cities with populations as low as 300,000, have opted for urban rail systems arguing that they are the most effective alternatives to the car.

Where new urban rail systems are built, there are expectations from them, such as an increase in public transport usage, a reduction in car traffic, and betterment of air quality. In addition, urban rail investment is often expected to have some impacts on land-use and urban development, such as new development in the city centre and in economically depressed areas, and a pattern of urban growth which is public-transport oriented. Some of the new generation urban rail systems have not been very successful in meeting these expectations. There has been considerable debate in the literature about the effectiveness of these investments: many commentators observed that new generation urban rail systems were not able to provide solutions for the contemporary problems of cities. Studies that focused on the success of urban rail systems have shown that while many new systems have not been very successful, their success could have been enhanced if the co-ordination between transport and urban planning had been stronger. However, co-ordination is very difficult to achieve within the contemporary local government structure and fragmented planning system. Therefore, improving the co-ordination between transport and urban planning to develop more successful urban rail systems has remained rhetoric. In spite of these findings, political support for urban rail systems is still strong, and investment in these systems continues. Considering the cost of these investments, it remains a challenge to make them successful.

This study is intended as a contribution to the discussions in the literature about the new generation urban rail systems. It seeks to provide a better understanding of the factors that affect the success of systems. Its principal aim is to develop a methodology for measuring success and identifying the factors behind it, and to design a planning framework which can advice planners how to influence these factors and help make urban rail systems more successful. The planning framework is a policy-based planning approach to help planners and operators to maximise the success of their systems. While it is planned to address the factors that influence success, there is a special focus on exploring methods for providing and sustaining co-ordination between transport and urban planning.

The research is organised in nine chapters. The current chapter, which introduces the topic and overview of the study, is followed by a comprehensive review of the literature and discussions about the new generation urban rail systems in Chapter 2.

Chapter 3 introduces the theoretical framework and the methodology of the study. In addition to the overall research methodology, methods of data collection and data analysis are discussed in this chapter, and eight urban rail systems are selected as the main case studies of the research. Four of them are in the United States, one in Canada, and three in Britain.

The planning processes and the operation of the eight case studies are analysed in Chapter 4. As well as the planning and operation of the systems, the background factors, that is the various external factors which may have affected the success of the systems, are also analysed.

The performance analysis of the eight case studies is presented in Chapter 5. Throughout the analysis, links are established between the success of the systems and the various factors that have been examined in Chapter 4. These links are the basis for the development of the planning framework.

In Chapter 6, the planning framework, which is the main product of the research, is developed. Its design is based on the analysis in Chapters 4 and 5. The framework, the aim of which is to help planners and operators to increase the success of their urban rail systems, has two functions: it predicts how successful a new urban rail system will be, and provides recommendations on how its success can be enhanced.

The planning framework is validated against nine other urban rail systems: seven in the United States, one in Canada, and one in France. The process, which is presented in Chapter 7, involves the estimation of the success of these systems, and the validation of the estimates against the actual performance of the systems.

In Chapter 8, the planning framework is applied to new urban rail systems in Britain and Turkey. The framework predicts how successful these systems are likely to be, and shows how their success can be enhanced.

Chapter 9 summarises the main findings of the study. It explores whether the research has met its principle aims and objectives, and concludes with a discussion on possible further research areas for which this study can be used as a basis.

2. NEW PUBLIC TRANSPORT SYSTEMS

2.1 INTRODUCTION

In the past three decades, there has been considerable concern about public transport systems, particularly about their effectiveness. Past decades have seen investment either in building new systems or upgrading existing ones. These investments, in general, are a response to the increasing use of the car and its undesirable effects on urban traffic and land-use. Traffic congestion, environmental pollution, uncontrollable urban growth, low density urban sprawl and declining city centres are among the problems. To solve them, an effective alternative to the car is required.

Urban public transport systems as alternatives to the car include a wide range of options, from buses, busways, and guided buses, to rail-based systems such as tramways, light rail transit (LRT), and heavy metros. In conventional bus systems, buses run in mixed traffic, whereas busway systems refer to buses that run on special roadways designed for exclusive or predominant use by buses. These roadways can be in separate rights-of-way or along streets and motorways containing car traffic. Guided buses too, run on separate lanes, but on a fixed guideway which makes the lane physically impossible to use by other vehicles. Guided buses are designed to be able to run on streets as well as on the guideway. Rail-based systems also offer several options. Tramways are electrically powered rail vehicles operating in one- to three-car units, mostly on streets with mixed traffic. Light rail transit, which is a relatively new mode of rail-transport, is a technology between tramways and the heavy rail systems. Light rail systems use electrically-powered rail cars operating singly or in short trains on fixed rail guideways, and run on predominantly segregated rights-of-way, but not necessarily grade-separated (i.e. vertical separation, above or below ground). Systems that use light rail vehicles on fully segregated rights-of-way are sometimes defined as light rapid transit systems, which usually have a third-rail power supply that is typical of heavy rail systems. Heavy rail systems, also called rapid rail transit, metro, subway, or underground, are high-speed electrically powered rail cars operating in trains in fully-segregated rights-of-way in underground tunnels, on elevated structures, in open cuts, or at grade, that is at the surface level (Vuchic, 1975; TRB, 1978, 1989; Schumann, 1989).

Public transport systems offer a wide range of options; however, recent investments in public transport have generally been in favour of rail-based options. Investment in metros, and particularly light rail systems, has significantly increased.

2.2 NEW URBAN RAIL SYSTEMS

Urban rail investments have become increasingly important in the past three decades, with 139 new urban rail systems world-wide. Since 1970, 61 metros and 78 light rail systems have opened[1], as listed in Table 2.1. It can be seen in the table that in the 1970s, investments on metro systems were dominant world-wide with 23 metros and 5 light rail systems, four of which were in the former Soviet Union. Trends in the 1980s and the 1990s, on the other hand, reflected the increasing popularity of light rail schemes: since 1980, 73 light rail systems and 38 metros have been built. Another important point in the table is the similarity of investment types in Western Europe and North America, as opposed to those in the rest of the world. While the Third and Second World countries continued to invest in metro systems in the 1980s and the 1990s, in Western Europe and North America the emphasis shifted towards light rail systems. Figure 2.1 illustrates the trends in both metro and light rail investments in those parts of the world: since 1980, in Western Europe and North America, only 9 metros have opened while the number of new light rail systems and trams amount to 42.

The rise of light rail systems has been a response to the expense of heavy rail systems, which, in some urban areas or in some specific urban corridors, are not feasible because of the cost or the level of demand. Heavy rail systems have certain advantages over light rail systems, such as higher operating speeds and capacities; they can also be very reliable

[1] Taplin's (1997, 2000) list has been used as the main source for the figures given. Light rail systems include trams; however, museum and heritage lines and those that Bushell (1997) identifies as serving very small urban areas are not included in the figures.

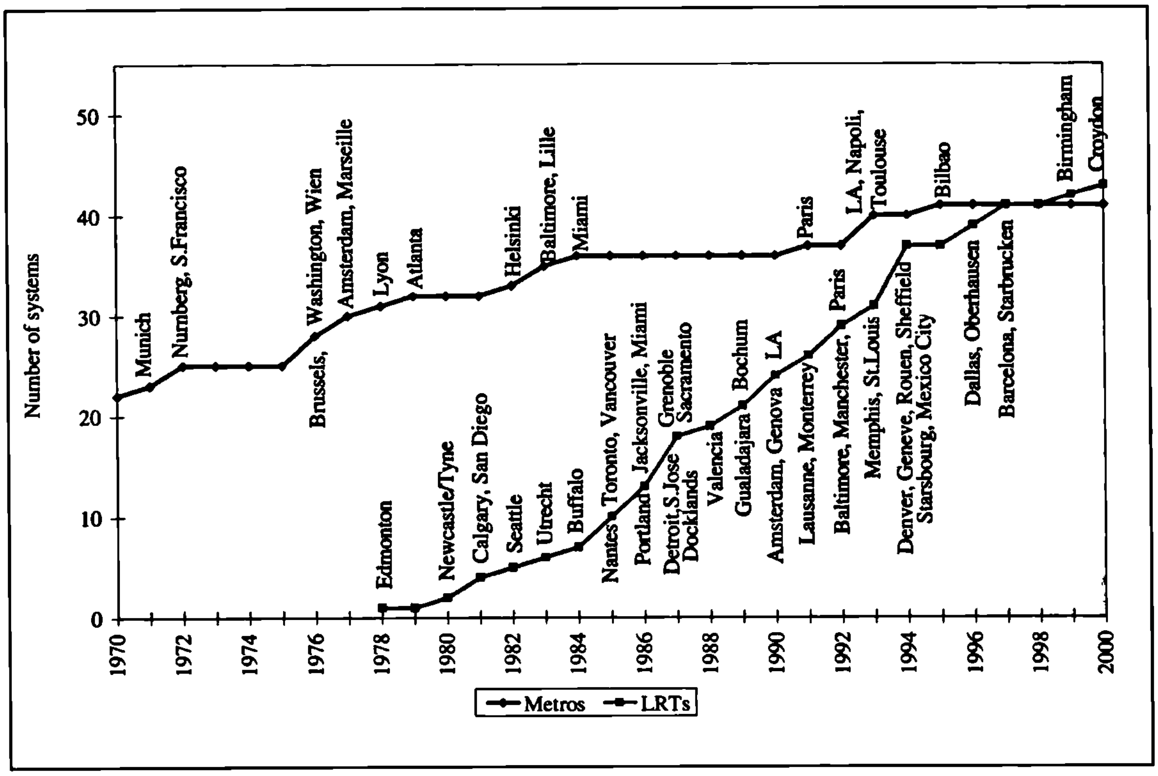
Table 2.1 Metro and light rail systems world-wide, opened since 1970

		Metro systems			Light rail systems and trams		
	Country	1970s	1980s	1990s	1970s	1980s	1990s
	Austria	Wien					
	Belgium	Brussels					
	Finland		Helsinki				
	France	Lyon	Lille	Paris		Grenoble	Paris, Rouen
		Marseilles		Toulouse		Nantes	Strasbourg
Western	Germany	Munich				Boschum	Oberhausen
Europe		Nurnberg					Saarbrucken
	Italy			Napoli			Genova
	Netherlands	Amsterdam				Utrecht	Amsterdam
	Spain			Bilbao		Valencia	Barcelona
	Switzerland						Geneve
							Lausanne
	UK					Docklands	Manchester
						Newcastle	Sheffield
							Birmingham
							Croydon
	Canada				Edmonton	Calgary	
						Toronto	
						Vancouver	
	Mexico					Guadalajara	Monterrey
							Mexico City
North	USA	Atlanta	Baltimore	L. Angeles		Buffalo	Baltimore
America		S.Francisco	Miami			Detroit	Dallas
		Washington				Jacksonville	Denver
						Miami	Los Angeles
						Portland	Memphis
						Sacramento	St Louis
						San Diego	
						San Jose	
						Seattle	
	Argentina					BuenosAires	BuenosAires
	Armenia		Yerevan				
	Australia						Sydney
	Belarus		Minsk		Nevapolatsk	Masyr	
Rest	Brazil	Rio de	B.Horizonte	Brasilia			
of the		Janeiro	Port Allegre				
world		Sao Paulo	Recife				
	Bulgaria			Sofia			
	Chile	Santiago					
	China	Hong Kong	Tianjin	Guangzhou		Hong Kong	
				Shangai			
	Colombia			Medellin			
	Czech R.	Prague					
	Egypt		Cairo			Helwan	
	India		Calcutta				
	Japan	Kobe	Fukuoka				
		Sapporo	Kyoto				
		Yokohama	Sendai				
	N. Korea	Pyongyang					Pyongyang
							Pyongyang
	S. Korea	Seoul	Pusan	Taegu			
	Malaysia						K. Lumpur
	Peru			Lima			
	Philippines					Manila	
	Poland			Warsaw			

(Cont.)	Country	Metro systems 1970s	Metro systems 1980s	Metro systems 1990s	Light rail systems and trams 1970s	Light rail systems and trams 1980s	Light rail systems and trams 1990s
Rest of the world	Romania	Bucuresti				Brasov Cluj Craiova Constanta Ploesti Resita	Botosani
	Russia		N.Novgorod Novosibirsk Samara	Yekaterin-burg	Nebereznye Ust Katav Volgograd	Stary Oskol Ust Ilimsk	Chermoyush.
	Singapore		Singapore				
	Taiwan			Taipei			
	Tunisia					Tunis	
	Turkey			Ankara		Istanbul	Ankara Antalya Istanbul Izmir Konya
	Ukraine	Kharkiv		Dnipropetr.		Kriviy Rih Molochne	
	Uzbekistan	Tashkent					
	Venezuela		Caracas				

Source: Bushell (1997), Taplin (1997, 2000).

Figure 2.1 Metros and Light Rail Systems (including new trams) in North America and West Europe since the 1970s



Source: TRB (1975); Bushell (1997); Taplin (1997, 2000).
Note: Graphing of light rail systems and trams is based on the list in TRB (1975) which recognises the Edmonton LRT to be the first modern light rail system in North America and West Europe, and all other investments earlier than that to be either extensions to, or rehabilitation of, old tram systems.

and punctual since their technology requires them to be fully independent of surface traffic. Therefore, in a large metropolitan area where the demand for public transport is sufficiently high, heavy rail systems offer opportunities for a good standard of public transport service. However, constructing a heavy rail system involves high costs; therefore, they tend to be economically inefficient for medium-size cities or for cities where demand is not very high, and for urban corridors which are not dense or public-transport friendly enough to support the heavy investment. Light rail transit has advantages over heavy rail systems in such cases. The cost of constructing a light rail system is less than that of heavy rail, and therefore, they can be economically justified in some medium-size cities which would not be candidates for heavy rail investment. In addition, light rail systems can be as effective as heavy rail systems in penetrating city centres. City centres generally consist of old narrow streets that can be served ideally by underground systems. However, light rail systems and trams have the technical capability of running in narrow corridors, without necessarily requiring underground construction or segregation from other traffic. Light rail systems are flexible in that they can be designed to have street-running segments to penetrate the city centre, and fully-segregated sections outside the city centre to provide services with higher speeds and higher degrees of reliability.

Light rail systems offer certain advantages for medium-size cities. In addition to medium-size cities, it is argued that they are seen as the solution to transport problems in large-size cities too (Black, 1993). Recent heavy rail investments in the United States, such as those in San Francisco, Washington, and Atlanta in the 1970s, and Baltimore and Miami in the 1980s, have been argued to be economically inefficient since the patronage of these systems, that is the number of passengers that they carry, has been insufficient to justify the costs incurred in their construction and operation (Black, 1993; Kain, 1997). Light rail transit emerged as a lower cost alternative not only for medium but also for large-size cities. Hence, in North America and Western Europe, light rail investments continue to increase; however, heavy rail investments have not been abandoned totally: metro construction continues, especially in large and densely populated cities in Third World countries.

Currently, urban rail systems appear to dominate public transport investments although buses remain the main mode of public transport in the majority of cities world-wide. As a response to the increasing amount of urban rail investment, there has been considerable debate focusing on the effectiveness of bus alternatives and a comparison of bus-based solutions to rail-based solutions, particularly to light rail. Guided buses, for example, have been described as being able to provide similarly effective solutions to urban transport problems (Read et al, 1990; Smyth, 1994), as well as to urban growth related problems since they operate on fixed guideways and therefore provide permanency (Biehler, 1989).

Obviously, choice of technology and appropriateness of technology should be seen to be specific to the urban area. Urban size, form, population, and demand for public transport should determine what the most appropriate choice of technology is for a given urban area. In addition, it would not be appropriate to consider each mode of public transport independently. A single mode of transport cannot respond to all the various transport needs of cities. Each mode, including the car, has to exist with others, and preferably in integration with them.

This study does not claim that any of the modes of public transport are unconditionally superior to the others; however, its main focus is on urban rail systems. The primary reason for this choice is that urban rail has become a major area of transport investment in recent decades, as illustrated by the figures given. However, there has been considerable debate in the literature, which will be discussed in the rest of this chapter, about the effectiveness and success of these new generation rail systems; many commentators have claimed that urban rail systems have not been able to provide solutions to the contemporary transport problems of cities. In spite of these findings and discussions in the literature, the political environment, especially at national level, still supports the development of urban rail systems as a means of tackling urban problems. Hence, although the new-generation urban rail systems are being criticised in the literature as not being as successful as expected, within current national and local policies it appears likely that investment in them will continue.

The rest of this chapter, therefore, first analyses in more detail, what the political background to development of urban rail systems is, why politicians and planners seem to favour these systems, and what they expect to achieve from developing new urban rail systems. Then the study reviews how successful recent urban rail systems have been in fulfilling these expectations, and seeks to explain the processes behind their success or failure, with an overview to explore whether or not these systems can be the solution to current urban problems.

2.3 REASONS FOR INVESTING IN NEW URBAN RAIL SYSTEMS

2.3.1 Policy background

Transport planning approaches in the 1950s and the 1960s were ruled by investments in the development and expansion of roads and motorways, and are responsible to some extent for the current level of the car use. In contrast to these approaches, since the 1970s some local and central governments world-wide have been searching for measures to limit the car use and promote public transport as an alternative. Hence, national policy documents, guidelines and urban policy initiatives in recent years, especially in North American and the majority of the West European countries, have all emphasised the need to provide a good public transport system (Hall and Hass-Klau, 1985; Simpson, 1987, 1988; Banister, 1994; Banister and Lichfield, 1995; Paaswell, 1995; Bernick and Cervero, 1997; Hass-Klau et al, 2000). It was built into these policy documents that new public transport systems were to be planned in order to provide effective solutions for urban problems, particularly for car traffic, environmental and urban growth problems.

Recently, the Environment, Transport and Regional Affairs Committee (2000) of the House of Commons in England stated that:

> "If the Government believes that it is important to attract motorists out of their cars, alternative forms of public transport must be put in place first. As the evidence shows, people will not switch to public transport unless it is reliable, frequent, efficient, safe and clean with affordable fares. Light rapid transit systems meet these criteria, and so, where appropriate, they should be pursued." (p. xxi)

In order to improve the environment, national policy documents tend to state not only the environmental benefits of rail, but also of the bus alternatives. Since buses require less road per seat than cars, the emissions that they cause per seat-km are less. However, rail systems appear to be in a more advantageous position since they are inherently more friendly to the environment than road vehicles. According to the Transport White Paper (Department of the Environment, Transport and the Regions, 1998a), in UK, new light rail systems are not to be encouraged unless it is proved that a scheme is good value for money and that the intended objectives cannot be met in alternative ways. However, it is also stated that for environmental concerns, rail-based options are far more beneficial than the road-based ones. In the USA, ISTEA, the Intermodal Surface Transportation Efficiency Act of 1991 and more recently NEXTEA, the National Economic Crossroads Transportation Efficiency Act of 1997 which reauthorises ISTEA, both provide for a Federal government contribution to urban rail investment in cities where the air quality falls below certain standards (Hass-Klau and Crampton, 1998).

When urban growth and land-use issues are of concern, policy documents appear to be more explicit about the effectiveness of urban rail systems. The Planning Policy Guidance Note on Transport (PPG13) by the Department of Environment and Department of Transport of UK, for example, emphasised the opportunities public transport offered in implementing locational policies, and stated that rail stations or light rail stops should be the preferred locations for travel-intensive development, because:

> "Rail services with their fixed infrastructure can provide the greatest certainty for developers and can provide a focus for regeneration and comprehensive redevelopment." (Department of the Environment and Department of Transport, 1994.)

In United States, Priest, of the Urban Land Institute stated that:

> "Urban rail transit can promote development and redevelopment in the major cities of the United States. It can do so not only in the older cities of the north-eastern and north central regions, but also in the auto-oriented cities of the South and West." (cited in Henry, 1989, p.174.)

Similarly, Austin (Texas, USA) Planning and Growth Management Department expressed the effectiveness of rail-based public transport systems as opposed to bus alternatives, in the following paragraph:

> "The influence of transit in stimulating development increases as the permanence and volume of the transit system increases. Bus systems which can be easily routed thus have less effect on development patterns than fixed guideway systems that represent a significant public commitment and generally carry a larger volume of passengers." (cited in Henry, 1989, p.176.)

In Continental Europe, in both Germany and France, national policies and funding arrangements appear to be even more committed to the development of urban rail, particularly light rail, in response to the worsening of urban transport problems. The Federal government contribution to the cost of urban rail investments in Germany has been recently raised to be up to 75% in the former West Germany, and up to 90% in the former East Germany (Hass-Klau and Crampton, 1998). In France, state policy, which gives substantial priority to the modernisation of existing rail routes, led to several new urban rail systems, particularly light rail and tram systems that partially utilised existing tracks. Moreover, projects of public transport on their own right-of-way are seen as the most eligible for state subsidy; and all guided modes on rail are eligible without ambiguity (Hass-Klau and Crampton, 1998).

The shift in national policies from the car to public transport alternatives, with growing emphasis on environmental and urban growth issues, seems to have contributed to the understanding that urban rail systems can be very effective in dealing with environmental problems and urban growth issues. Indeed, these issues generally appear to be among the main objectives for developing urban rail systems; they play an important role in deciding to build a new system (Simpson, 1988; Fouracre et al, 1990; Walmsley and Perrett, 1992). However, decision to build a new system involves other objectives in addition to the environmental and urban growth related ones. The following section focuses on these objectives.

2.3.2 Objectives for investing in new urban rail systems

There have been studies that have examined several new public transport systems together, particularly urban rail systems. These studies deduced some sets of objectives that seem to be applicable to new public transport investments world-wide.

Simpson (1994), for example, suggested that although there were differences in emphasis according to the political system of countries, some of the objectives set for urban rail systems were fairly international. He listed five objectives that new urban rail systems were generally expected to attain: to improve public transport services, to reduce road traffic, to promote commercial development, to form a focus for urban growth, thus reduce car-oriented urban sprawl, and to promote the external perception of the status or image of the city.

Walmsley and Perrett (1992), who have conducted a comparative research of new urban rail systems world-wide, grouped the objectives they have observed under four headings: transport objectives, objectives relating to environment and image, objectives relating to urban form, and personal and political objectives. The first set referred to objectives such as improving public transport and reducing car congestion. The second set included improving environment in terms of reducing pollution from cars, and improving the image of a city. The third set of objectives contained the improvement of urban structure by providing opportunities for development and enabling planners to focus urban development, and the prevention of urban sprawl by strengthening the central business district (CBD). The fourth set of objectives, as the authors stated, were not usually quoted as reasons for building a rail system; however, local political support and a strong personality who could exert influence have sometimes been important factors in decisions.

Fouracre et al (1990), in their study on rail mass transit in developing countries, included the financial and economic concerns among the objectives. They listed the arguments given in official reports for the development of metros, and presented ten reasons for building metros, which, in order of importance, were: to raise the quality of public transport, to relieve traffic congestion, to carry forecast volume of passengers, to promote land-use policy, to make the environment better, to support local industry, to support energy policy, to save road accidents, to be financially viable, and to be economically viable.

Mackett and Edwards (1996), who have examined the decision-making processes for new urban public transport systems, identified eight objectives and grouped them under three headings: objectives related to obtaining the system, building a cost-effective system, and maximising the impacts of the system. The first set of objectives included to obtain authorisation, to obtain funding, to choose the right mode, and to build the system. Objectives related to cost-effectiveness were to keep the cost down and to minimise financial risk, while the objectives related to maximising system impacts were to have high patronage and to stimulate development.

In the report prepared by the European Conference of Ministers of Transport (ECMT, 1994), nine objectives were identified for developing new light rail systems: to increase mobility through the increased usage of public transport; to reduce the use of private vehicles by diverting passengers to public transport; to supplement automobile disincentive measures and make them more acceptable; to reduce transit subsidy levels as a result of higher passenger densities; to reduce air pollution and energy consumption through the reduction in private vehicle use; to reduce the number of automobile accidents; to improve urban environments so that they are more liveable and environmentally benign; to support central city revitalisation as part of an overall plan; and to contribute to the economic stimulation of less developed regions of a country.

Based on these objectives, and based on the interviews made with planners for this research, the objectives of developing urban rail systems are allocated to five groups in this study: to attain high patronage on the system; to increase public transport usage; to build and operate the urban rail system in a cost-effective way; to reduce car traffic and environmental pollution associated with it; and to improve the land-use and urban growth patterns. The last objective refers to sub-objectives, such as to stimulate development at city centres; to stimulate development at economically declining areas, to improve the pattern of urban growth by reducing car-oriented sprawl, and to improve the image of the city.

There are perceptions that urban rail systems are more effective than buses in fulfilling these objectives. For example, Black (1993) argued that rail systems (in the context he argued, light rail systems) were believed to attract more passengers than buses because their average speeds were higher than those of buses, which was a result of their lower stop spacing and separate rights-of-ways. He also claimed that passengers were attracted to urban rail systems because they provided a more comfortable ride than buses, and had a better public image. Having a positive public image is a widely discussed issue for rail systems. Wood (1994) claimed that light rail had the ability to attract more people to public transport than buses did on their own because many people who would never consider using buses would be willing to use a rail-based system. Simpson (1994) argued that public transport in general had a poor image, but that 'especially buses are widely regarded as being something to avoid by anyone who has private car' (p.8).

For cost-effective and efficient operation, recent investment in heavy rail systems has been discussed to be very expensive and inefficient (Black, 1993); however, it has been claimed that light rail systems are cost-effective and that the operating costs of some light rail systems are even lower than those of buses (Morris, 1975; Black, 1993).

In reducing traffic congestion and environmental pollution too, it is claimed that urban rail systems can offer advantages over buses. Parkinson (1989), for example, argued that there could be significant localised improvements in air quality where a city centre street was converted from congested traffic to a light rail corridor with a transit-pedestrian mall.

As for the attainment of land-use related objectives, urban rail systems are historically believed to be able to manage urban growth by directing development and creating denser settlements along themselves (Banister and Lichfield, 1995). In improving the pattern of urban development, urban rail systems are seen to be more powerful because providing high capacity transit service along a fixed track is believed to have stronger land-use impacts and stronger influence on development compared with any land-use impact or influence of bus services (Parkinson, 1989; Schumann, 1989). Similarly, in reinforcing declining city centres, an urban rail system is seen as an effective tool with both the accessibility it provides and the positive image it has. Simpson (1988) suggested that a lot of cities were willing to reverse the decline of city centres and decentralisation of city centre activities by heavy investment in public rail transport. Urban rail systems are believed to be able to stimulate development even in declining areas. Parkinson (1989) claimed that 'the fixed tracks of streetcars or light rail provide an indication of support, commitment, and continuity to the community and neighbourhoods served; this is a catalyst that can trigger renovation, redevelopment, investment, employment, and even recovery for economically depressed areas' (p.68).

Proponents of bus systems, on the other hand, have been claiming that separate busways and guided busways can be as effective as rail-based options in achieving these objectives. Read at al (1990) argued that busways could be equally successful in attracting car passengers since they had a new and modern image. Smyth (1994) argued that busways could provide similarly fast and reliable services since they could be operated free from car traffic. As for environmental issues, new technologies enable environmentally friendly vehicles for bus operations. The operating costs of these types of bus services on busways may not be as cheap as those of conventional buses; however, it has been illustrated that they still can provide cheaper services than light rail systems (Biehler, 1989). For the fulfilment of land-use objectives, too, it is argued that some bus systems, in particular guided bus systems and separated busways, can be as effective as light rail systems since they have fixed guideways (Biehler, 1989). There are busway implementations such as Ottawa-Carleton, in Canada, and Curitiba, in Brazil, which have proved that busway systems can be as successful as rail systems (Lloyd-Jones, 1996; TRB, 1996a). However, such examples of busway systems with strong land-use impacts are limited (or the documented examples, to the knowledge of the author, are limited). Examples of guided busways are limited too; implementations are, as yet, very small scale, with examples in Adelaide, Australia; in Essen and Mannheim, Germany; in Ipswich and Leeds; UK, and in Rochefort, Belgium. It still remains to be seen how successful these systems will be when they become more extensive.

As a result, urban rail alternatives are perceived to be very effective in solving both transport and land-use related problems, and this perception has led to large numbers of new urban rail systems in the past decades.

2.4 SUCCESS OF NEW URBAN RAIL SYSTEMS

Many new systems have been justified with the argument that they would be more successful than other public transport systems in fulfilling the objectives regarding the solution or prevention of transport problems, most of which are associated with the extensive use of the car. It is not very easy, on the other hand, to claim that new urban rail systems have always succeeded in fulfilling their objectives. While there are some successful systems, a number have hardly had any impact on urban transport or land-use. These experiences, which are verified by several impact studies, have given rise to a broad area of debate in the literature, as discussed below.

One way to measure the success of new urban rail systems is to compare their patronage and financial performance with those that were anticipated during the planning of the systems. In addition, the comparison of systems' impacts on both traffic and land use with those that were expected to be achieved, plays an important role in determining whether or not the systems are successful. Hence, the levels of attainment of the objectives that were summarised above can be used to determine the level of success.

Attainment of the anticipated level of patronage is a particularly important measure of success because a high level of patronage helps achieve other objectives. In addition to patronage, the system being built within budget, that is, the system not exceeding the estimated cost of construction, is another valuable way of determining success. Studies often show that the patronage of the systems and the non-user benefits that were expected from them, such as the relief of traffic congestion and improvement of air quality, are overestimated while the capital and operating costs are underestimated, as explained below.

An important part of the debate about the success of the systems has been the quality of the forecasting procedures since these have been a major source of the problems. Studies which have explored the reasons behind inaccurate forecasts and aimed to improve the techniques for forecast modelling include Gordon and Willson (1984), who proposed a new model for demand forecasting. The outputs of this model suggested that the official forecasts for a number of North American systems were very optimistic. Pickrell (1990) compared the patronage and cost forecasts with those achieved for ten systems in the United States, and concluded that specific technical improvements in forecasting procedures, such as setting a near horizon year, including sensitivity analysis, and incorporating uncertainties into the forecasts, were essential in order to improve their accuracy. Mackett (1998) analysed patronage forecasts for systems in North America and England, and listed several factors that made accurate forecasts difficult to achieve. He suggested that current modelling techniques used in forecasting were unsatisfactory and that new techniques should be developed.

In addition to technical issues, the overestimation of patronage and underestimation of costs are believed to be caused by the political system of project planning and fund allocation (Johnston et al, 1988; Pickrell, 1992; Moore, 1994; Edwards and Mackett, 1996; Mackett and Edwards, 1996, 1998; Mackett, 1998). It has been argued that public transport planning guidelines and the criteria of grant approval, especially in the United States and the United Kingdom, create incentives for the overestimation of patronage and the underestimation of costs. The recognition that these estimates are often inaccurate, leads to the question whether rail technology was appropriate in the first place for a number of cities. Studies that analysed the process of technology selection (Pickrell, 1990; Edwards and Mackett, 1996) have concluded that in many cases rail technology has been selected through a built-in bias created by the political system of the countries, and that local planners and politicians have a strong commitment towards building rail systems, whether or not the urban environment and public transport demand justify their construction.

In addition to the overestimation of patronage, other benefits expected from urban rail investments are often overestimated. Mackett and Edwards (1998) observed in a number of systems world-wide that although there was evidence of some reduction in traffic congestion and air pollution, the effects were not strong enough to create the expected reductions. Hass-Klau and Crampton (1998) argued that most light rail systems had not been as successful as they were expected to be in helping lure car drivers out of their cars and reduce traffic congestion. Gomez-Ibanez (1985), in his article on light rail systems of San Diego, Calgary, and Edmonton, argued that light rail transit proponents oversold this system by underestimating the costs incurred and overestimating the positive impact that these systems were supposed to have on urban transport. He claimed that these systems had had hardly any impact on public transport patronage, traffic congestion, or air quality, and asserted that other cities considering LRT should be sceptical of claims that light rail would have such impact. Richmond (1998a) also showed that the contribution of new urban rail systems to increases in public transport patronage, or reductions in traffic congestion or air pollution had been minimal in most cases, and that changes in bus operating practices designed to accommodate rail had generally had a negative effect on the financial productivity of the overall public transport system.

These findings suggest not only that some urban rail systems have been unsuccessful, but also that a number of recent urban rail systems would not have been built if the costs and benefits were correctly predicted. Hence, some critics who are sceptical about rail-based systems have argued that for many cities that recently built urban rail systems, bus technology would have been a more appropriate choice. This argument seems to be applicable particularly for some American cities. Kain (1988), who analysed some low density sun-belt cities in the US, concluded that developing busways, either on exclusive rights-of-way or on uncongested high occupancy vehicle lanes, would have been a much more cost effective way of providing improved transit in these cities than the heavy or light rail systems that these cities had recently built. In a more recent study, Kain (1997) observed Atlanta's heavy rail system, and argued that although the system was one of the most successful rail systems built in the US since the World War II, the transit authority which developed the system would have had much more success in increasing public transport patronage if it had continued its prior policies of expanding bus service-miles and low fares, rather than building an expensive rail system and raising fares. Similarly, Wachs (1993) observed in Los Angeles that the recent rail-based policies in the city had very high financial costs in comparison to their benefits, which were only small shifts towards public transport. He argued that in a region of low density, providing busways would have yielded more public benefit than an underground subway, and added that 'the opportunity to expend funds on busways is limited by the extent of our commitment to the rail network' (p.13). Richmond (1998b) approached the issue from a 'public image' point of view, and suggested that 'metaphorical' perceptions made rail systems appear superior to buses and that these metaphors made planners invest in rail systems although bus alternatives were more effective in many cases, and especially in the Los Angeles case.

Indeed, urban rail investments are not appropriate for every city; they are particularly unsuitable for the extremely low density urban areas of some American cities. On the other hand, the policies of the US Federal Government and some State governments, one of which is California with its low density sun-belt cities, put considerable emphasis on building urban rail systems. They anticipate that these systems will help create higher density urban areas since they provide an opportunity to implement urban development projects that are public-transport friendly. These projects which are referred to as 'transit oriented development (TOD) schemes' play a substantial part in the land-use policies of

State and local governments. Therefore, planners in urban areas where urban rail systems are not cost-effective and do not help achieve transport-related objectives, may believe that it may still be worthwhile investing in these systems if they help fulfil the land-use objectives. However, there is evidence, as presented below, that many new urban rail systems have also failed in attaining their land-use objectives.

In the literature, studies that find urban rail systems effective in achieving land-use related objectives are very rare. In general, impact studies suggest that urban rail systems have been best in reinforcing the city centres since the commercial activity in city centres benefits from improved accessibility (Robertson, 1980; Fouracre et al, 1990; Cervero and Landis, 1997), and from supporting measures, such as restrictions on car use (Simpson, 1989; Hass-Klau et al, 2000) and pedestrianisation schemes which are well integrated with new systems (Walmsley and Perrett, 1992; Black, 1993; Hass-Klau and Crampton, 1998; Hass-Klau et al, 2000). On the other hand, it cannot be known whether the pedestrianisation and other improvement packages would have been equally effective without having urban rail systems as a part of the package (Simpson, 1988, 1989). Studies suggest that urban rail systems "cannot save a city if the city is going down since the forces that are taking it down are far wider and far deeper than mere questions of accessibility" (Hall and Hass-Klau, 1985, p.169), but that they will help intensify developmental processes which would have taken place anyway; and when supported by environmental improvement measures, they will also contribute to the enhancement of city centres (Simpson, 1988, 1989; Walmsley and Perrett, 1992).

The attainment of other land-use objectives of urban rail systems, namely to manage urban growth and to revitalise declining areas, can be analysed by examining the impact of new systems on urban development and land-use. There have not been many examples where new systems had profound effects on urban development and land-use of the cities they serve. However, there are some successful systems, and some impact studies have aimed to explore the factors and processes behind their success. Portland light rail system, which is generally regarded as being successful in influencing land-use, was well integrated into, and supported by, land-use policies, and therefore contributed significantly towards the building of communities along its route (Glick, 1992; Arrington, 1995; Dunphy, 1996, 1997; TRB, 1996a, 1997a). In addition to Portland, there have been similar planning efforts to promote transit oriented development in San Diego and

Sacramento (Glick, 1992). However, the impact in Sacramento does not seem to be strong because low density urban sprawl is a very dominant trend in the city, and since the 'vast areas of the surrounding county are without development restrictions, developers need not stop at the city line' (Dunphy, 1996, p.87). Station area developments around Washington DC Metro and Vancouver SkyTrain are seen as successful examples where the implementation of transit oriented development schemes have enhanced the developmental impact of the systems (TRB, 1996a). Toronto's land-use policies are considered to have helped the success of Toronto Metro significantly, and are also considered to be the main reason why Toronto has become a model of a pro-transit city in North America (TRB, 1997b). The light rail system in St Louis is also recognised to be a successful example with its good level of patronage and the development it attracted near to its stations: its success is associated with the city's convenient land-use pattern as well as the compatibility of the location of the line with trip generating activities (Warren, 1995). In addition, French systems are generally thought to be successful in having positive impact on their environments; their success is explained by the use of land-use planning projects to back up the new urban rail systems (Simpson, 1989). Tram systems in Nantes and Grenoble, in France, for example, have successfully upgraded the urban environment they serve (TRB, 1996a). The Strasbourg tram also had strong positive impact on the urban environment (Hass-Klau et al, 2000).

There have been comparative studies which have aimed to understand why some new systems have been successful in attaining land-use objectives, while others have had hardly any impacts, and particularly what are the most important factors behind the attainment of land-use objectives. Knight and Trygg (1977), in their land-use impact analysis of urban rail systems in North America, found that for substantial land use impacts to occur, local government policies, regional development trends and physical characteristics of the site must be favourable to the line, while there also must be developable land available along the line. Gomez-Ibanez (1985) concluded that for urban development to be achieved along new urban rail systems, the metropolitan area must be already growing, and there must be supportive zoning. He also added that new rail systems must produce significant improvements in transport service quality or accessibility in order to attract development at their stations. Walmsley and Perrett (1992), who examined several new urban rail systems world-wide, observed that development could be channelled only if there was demand for residential or commercial development, that is, the economic conditions favoured urban growth. They also found that the greatest effect on urban development had occurred in cities where there had been a long process of urban planning in conjunction with the rail system. Research done by Transportation Research Board (TRB, 1996a) had similar findings. It has been observed that development around stations would occur if the investment coincides with regional growth or if the local authority has a regional growth vision, using the new rail line as an instrument to fulfil this. In addition, the condition that the stations must have development potential has been found to be important (TRB, 1996a).

There are several other impact studies referred below, which together with the above studies have shown that for a system to achieve its land-use objectives, there are three major factors. First, the urban form should be suitable for the development of an urban rail system, and the land around stations should be available for development. Second, the line should be compatible with the developmental and economic trends, which also implies that the economy of the city should be prosperous, particularly for the investment to have a positive impact on the city centre. Third, there should be a strong integration of urban and transport planning. As discussed below, some of these factors are important for the attainment of other objectives too.

The urban form is an important factor for both attaining a good level of patronage, and for the rail system to have substantial impacts on land-use and urban development. High density, for example, is an important element of the urban form that is likely to enhance the success of urban rail systems (Knight and Trygg, 1977; Dunn, 1980; Cervero, 1994; ECMT, 1994). High density would not only help the patronage of systems but also make it possible to encourage public-transport oriented high density developments along the new line. The existence of radial corridors would also be an advantage because the urban rail system can penetrate a larger proportion of population and development (Fouracre et al, 1990; Warren, 1995). There also needs to be developable land available at station areas, as Knight and Trygg (1977), Gomez-Ibanez (1985) and the TRB report (1996a) argued.

The second important factor for the success of systems, and particularly for the attainment of land-use objectives, is the compatibility of the new urban rail line with existing development trends, and the presence of favourable economic conditions. When the metropolitan area is already growing (Gomez-Ibanez, 1985; Simpson, 1989; Walmsley and Gardner, 1993), and the new line coincides with this regional growth (Knight and Trygg, 1977; TRB, 1996a), the new system can be expected to be powerful in stimulating urban growth. Similarly, when the economic climate is favourable, the rail line is more likely to generate urban development along itself (Knight, 1980; Simpson, 1989; Fouracre et al, 1990), or at least increase the rate of urban growth (Banister and Hall, 1995), which would in return enhance the patronage.

The third factor, co-ordination of urban planning and transport planning, is seen by many authors to be the most crucial factor for the attainment of land-use objectives. It is believed that investments in urban rail can result in substantial impact on the city centre and on urban growth when the rail system is planned in conjunction with the urban plans (Priest, 1980; Miller et al, 1989; Glick, 1992; Walmsley and Perrett, 1992; ECMT, 1994), and as an instrument for the fulfilment of a local vision that is shared by all local authorities (Mackett and Edwards, 1996; TRB, 1996a, 1997b), and when local government land-use policies and management are consistent with and supporting the new rail investment (Knight and Trygg, 1977; Knight, 1980; Skinner and Dean, 1980; Gomez-Ibanez, 1985; Miller et al, 1989; Pucher, 1994; Dunphy, 1996, 1997; Allport and Bamford, 1998). In addition to strategic planning, during the implementation of the project and the operation of the system, encouraging developers to locate around the stations by means of incentives such as tax reductions and development bonuses (Miller et al, 1989; Walmsley and Perrett, 1992; Pucher, 1994; Mackett and Edwards, 1996; TRB, 1996a), or by means of leveraging of private investment at station areas, such as joint development schemes (Priest, 1980; Skinner and Dean, 1980), are also believed to be extremely effective in helping development occur along the new line.

Co-ordinating transport planning and urban planning helps the fulfilment of not only land-use objectives but also the transport-related ones. Planning the urban rail system in co-ordination with existing urban development trends, as well as with the development and land-use strategies, would result in more favourable conditions for higher usage of the system. In addition to this, implementing land-use policies, plans, and actions that are compatible with, and supporting, the new rail line would increase the attraction of the land and settlements adjacent to it, and help achieve land-use objectives, such as creating a transit oriented land use, which in return would increase the patronage of the system.

The benefits of establishing such symbiotic relationships between transport and land use are evident from a number of impact analysis studies (Walmsley and Perrett, 1992; Cervero, 1994; Mackett and Edwards, 1998).

The recognition that policy co-ordination is an important determinant of success for urban rail systems does not necessarily mean that policy co-ordination has improved, or has been given a stronger emphasis during the planning of recent urban rail systems. In their latest impact study on BART, the heavy rail system in San Francisco, Cervero and Landis (1997) concluded that the findings of the original BART impact study, which was conducted a few years following the system's 1973 opening, had not been altered much by the passage of two decades. The recent study found that the system attracted office and high density residential development only at some specific stations where the development authorities took aggressive actions towards transit oriented development. However, such actions were not adopted by all local authorities, and therefore were not comprehensive and sufficient to help the system shape metropolitan growth and land-use patterns. In Britain, Knowles (1994), who was involved in a comprehensive impact study on Manchester Metrolink, came to the conclusion that the system had had negligible impacts on the land-use and urban development of the city. Although one of the reasons that the effects were insignificant was that the system was built very recently, Knowles attributed it to other factors too, including uncertainties in the planning system and the lack of pro-active planning to steer development towards the Metrolink corridors. For Sheffield Supertram, which is not considered to be very successful, Fox (1996) identified the deregulated bus regime with its lack of bus-tram co-ordination as the main reason behind the failure, but he also cited town planning actions, which entirely conflicted with the tram system, as one of the major issues. A recent report by the Environment, Transport and Regional Affairs Committee (2000) of the House of Commons in England suggested that one of the reasons why Sheffield Supertram failed to achieve expected levels of patronage was because transport and land-use policies were not properly co-ordinated. Rowley (1995) argued that for the Supertram to have stronger land-use impacts, there had to be a city-wide planning scheme, which was not apparent at the time of planning. For the Tyne and Wear Metro, Davoudi et al (1993) and Heseltine and Mulley (1993) found that the system had almost no effect on urban development, and explained this by the fact that planning and economic development policies in the urban area had been entirely contradicting the Metro.

It can be concluded that co-ordination between urban planning and transport planning is as an extremely important factor for the success of urban rail systems in attaining almost all types of objectives; however, it is often not put into practice, and remains as rhetoric.

2.5 OVERESTIMATED SUCCESS OR UNCOORDINATED PLANNING?

Impact studies conducted on several urban rail systems world-wide have illustrated that these systems often fail to fulfil their objectives. Evidence suggests that sometimes expectations for urban rail investments are set very high. These investments alone are not powerful enough to improve conditions regarding urban transport or urban development. Public transport in many cities, particularly in North America, plays a minor role in urban transport; therefore, the addition of a new rail line to the network does not provide a strong enough factor to convince car users to abandon their cars and travel by public transport. When even the expected patronage levels on the new system are not reached, it is unrealistic to expect any significant reduction in traffic congestion or environmental pollution. Similarly, proximity to urban rail systems is not powerful enough to influence decisions of where to live or where to locate businesses; it is only one of several factors that influence locational decisions. An urban rail system in itself is not a sufficiently strong factor to control and direct urban growth, or to revitalise the city centre and declining areas. From these points of view, the transport and land-use impacts of building a new urban rail system are often overestimated.

On the other hand, many authors and commentators have come to a common conclusion that the achievement of both transport and land-use objectives was possible provided that supportive land-use policies are developed, and are strongly co-ordinated with transport investments and policies. Most of the studies on land-use impacts of urban rail systems have interpreted success as being enabled by a supporting urban form and a favourable economic climate, but more importantly, by a healthy regional and town planning process that the new system was planned in conjunction with, and which supported the system during its construction and operation. These factors are seen also to be capable of helping the systems achieve their transport objectives.

The problem in urban rail system planning, then, is not merely the overestimation of success. It appears that the lack of a co-ordinated process of urban planning and transport planning is an important reason behind the failure of urban rail systems to achieve their objectives.

Twenty-three years ago, Wachs (1977) suggested, in his article 'Transportation policy in the Eighties', that if investment on rapid transit was to be justified, a new kind of comprehensive planning would be required to promote joint planning of land use and transit facilities, which would also include incentives such as zoning variances, permissive regulations, and development incentives to support the new investment:

> "The lessons of BART and (Washington) Metro will be that heavy transit systems cannot financially sustain themselves without such planning in cities in which the automobile is dominant. Few rapid transit systems will be built in the future in the absence of such comprehensive strategies ..." (Wachs, 1977, p.116)

However, 19 new rail transit systems opened in the United States after the writing of the above article, most of which were built and operated 'in the absence of such comprehensive strategies'. Although only 4 of them were rapid transit, that is heavy rail, experience showed that the majority of light transit systems, too, could not financially sustain themselves without the type of planning approach that Wachs hoped would be common in the Eighties.

It appears to be quite explicit that although the reasons for failure, and the factors behind the success, of urban rail systems are known and widely accepted, these findings cannot be put in practice. Both researchers and planners know that strong co-ordination between transport and urban planning is the key to success, but new urban rail systems still fail to provide the transport and land-use connection, and end up in failure. Why does the importance of policy co-ordination remain as rhetoric and not put in practice?

The answer to this question lies in the local government restructuring that has taken place since the late 1970s. As a result of fundamental changes in the world economy and in political systems, central and federal governments in the western democracies have restructured local governments to make them fit better into new ideologies. Changes in national politics and in new local government structures have had important implications for urban planning, as well as transport planning. It was inevitable that these changes would affect the level of co-ordination between urban and transport planning.

2.6 THE RESTRUCTURING OF LOCAL GOVERNMENT

2.6.1 The implications of changes in economic and political systems for local government

It is an area of broad agreement that the interaction between urban transport and land-use can not be isolated from the social, economic, political, and institutional contexts in which the interaction takes place (Gillespie, 1980; Hall and Hass-Klau, 1985; Simpson, 1987; Banister and Lichfield, 1995; Wegener, 1995). Likewise, the determinants of the level of co-ordination between urban planning and transport planning needs to be evaluated within the social, economic, political, and institutional contexts, in which they take place.

Since the late 1970s, there have been changes in economic systems world-wide, followed by new political ideologies in the majority of western democracies. Changes in the world economy affected urban economies while new political ideas influenced local government structure as well as urban planning approaches and practices. They have been well documented in the areas of local government, urban policy and urban planning (see for example, Brindley et al, 1989, 1996; King and Pierre, 1990; Logan and Swanstrom, 1990; Pickvance and Preteceille, 1991; Goodwin et al, 1992; Jacobs, 1992; Wolman and Goldsmith, 1992; Healey et al, 1995; Stewart and Stoker, 1995; Fainstein, 1996; Hall, 1996; Taylor, 1998). Political movements had profound effects on the transport industry too. For example, the encouragement of the private sector in undertaking transport operations, and particularly the deregulation of buses in England outside London, has become an area of research: the implications of these issues for the performance of public transport systems have been well documented (Gwilliam et al, 1985; Mackie at al, 1995; Tyson, 1995; White, 1995). Since urban planning and transport planning were radically affected by the economic and political changes, it was inevitable that the area in-between them, namely the co-ordination between transport and urban planning, would also be affected by these changes. Indeed, economic and political trends had dramatic effects on the policy co-ordination that can be achieved between transport planning and urban planning, as described below.

2.6.2 Local government restructuring

The co-ordination between urban planning and transport planning was affected by the changes in the economic and political systems particularly where these trends resulted in the restructuring of local governments. The restructuring of local governments seem to be based on two driving forces: economic restructuring which was facilitated by the internationalisation of economies, and the rise of neo-liberal, that is the New Right, policies in the late 1970s and the 1980s (Logan and Swanstrom, 1990; Moore, 1990). At the centre of the New Right policies lied the need to cut public sector expenditure, and facilitate market economies. Local governments were restructured to fit in this ideology.

In order to ensure that public spending was cut, central governments reduced the fiscal autonomy of local governments (Parkinson, 1990; Fainstein and Fainstein, 1991). This involved reductions in Central and Federal government funds as well as restrictions on local government for raising their own local revenues. As a result, the first effect of New Right policies appeared to be the financial restructuring of local governments.

Financial restructuring has often been accompanied by a pressure on local governments to attract the private sector in all kind of tasks that were traditionally accepted to be in the responsibility of local governments (Moore, 1990; Parkinson, 1990). In many cases, central governments introduced some arrangements for the privatisation or contracting out of public services. Such arrangements were particularly significant in countries where municipal planning tradition was strong, such as the UK, as opposed to countries which already had the tradition of municipality-business partnerships, such as the USA and Canada (Logan and Swanstrom, 1990; Magnusson, 1990a; Wolman, 1990; Hamel and Jalbert, 1991; Keating, 1991; Pickvance and Preteceille, 1991).

Financial restructuring and the privatisation and contracting-out of public services have not been the only tools of forcing local governments to adopt a market-oriented approach in their activities. Central governments intervened more radically in local government activities in order to secure the involvement of the private sector in urban investments. Economic regeneration projects have been the most common type of investment that the central government intervention took place in. Rehabilitation, regeneration, and redevelopment of economically depressed areas have become a major planning problem since the 1970s as a result of the decline of manufacturing economies. The New Right governments encouraged the private sector to regenerate declining areas, and secured this by establishing centrally-appointed planning agencies that by-passed local authorities, such as Urban Development Corporations in the UK, or by creating special planning zones, where planning controls and regulations were relaxed and predominantly controlled by the central government, such as Enterprise Zones in the US and the UK (see Parkinson, 1990; Fainstein and Fainstein, 1991; Pickvance and Preteceille, 1991; Taylor, 1998; Imrie and Thomas, 1999). These interventions created a planning system which was very much centrally controlled, but more importantly, very fragmented locally.

Fragmentation of planning became even more apparent in the UK after the abolition of metropolitan authorities in 1985, which left several local authorities operating in the same urban area with a very poor level of co-ordination with each other (see Wilson and Game, 1994). Strategic planning at the metropolitan level ceased with the abolition of the metropolitan county councils.

2.6.3 Effects of local government restructuring on planning co-ordination

Transformation of local government structure has had profound effects on the level of co-ordination that can be achieved between urban planning and transport planning. Three such effects can be listed.

The first impact of local government restructuring is related with the financial problems that the local governments suffer from. Because of lack of local sources, affordability and profitability comes out to be the most important criteria in the construction and operation of urban rail systems. The necessity of building and operating the system cost-effectively is often more important than the necessity of planning and operating in co-ordination with urban plans, policies, and projects.

The second implication of local government restructuring for planning co-ordination is the effects of privatisation and contracting out of public services. Privatisation of local government assets, such as the housing stock of local governments in Britain, has meant that local governments have fewer powers to manipulate town plans or projects in a way to support the urban rail systems that they plan. Contracting out of public services, particularly public transport services, too, affects the level of planning co-ordination. The most apparent disadvantage seems to be the difficulty in providing co-ordination between different public transport operators; however, the impact on the co-ordination of land-use and transport policies are not negligible. Private operators would prefer to serve profitable routes or provide service levels in the most profitable ways possible, rather than consider their service as a means of directing and controlling urban growth, or providing a service in line with the regeneration or rehabilitation purposes of a local government. The private operation of buses or urban rail systems does not mean that it is impossible to provide co-ordination between operators and planners, but that there is very little incentive to make them co-ordinate their policies.

Thirdly, the introduction of temporary planning institutions and other arrangements that weakened local planning power had a profound impact on town planning, transport planning and the level of co-ordination between them. Although central governments stepped back from local economic regeneration responsibilities, especially funding responsibilities, this did not mean that their intervention in planning decreased. On the contrary, central government intervention increased significantly with the introduction of centrally-appointed agencies and Enterprise Zones. With these interventions, local governments lost their planning powers in particular sites in urban areas. There were no legal arrangements to provide compliance between city-wide policies and the policies governing centrally appointed agencies or the Enterprise Zones.

The resulting structure of local governments may have varied between different countries; however, restructuring and market-oriented approaches to municipal activities have affected many countries. Loss of planning co-ordination as well as the loss of comprehensive planning have been experienced by most local governments.

To summarise, local government restructuring resulted in fragmented planning and an institutional setting which does not appear to be appropriate for a well co-ordinated process of transport and urban planning. Although many impact studies on new urban rail systems have proposed guidelines for system planners, in which co-ordination between transport and urban planning was often a vital component, they have seldom addressed the existing political and institutional settings which are likely to discourage and even impede the establishment of strong policy co-ordination. Local government policies and structures and the way they shape town and transport planning practice are important factors behind policy co-ordination, and consequently the success of urban rail systems. It is the principal claim of this study that recent urban rail systems have failed to be as effective as expected because urban planning and transport planning were poorly co-ordinated, and this was due to the fact that the political and institutional settings of town and transport planning changed in such a way that a comprehensive and co-ordinated approach to urban rail system development was extremely difficult.

2.7 IS IT POSSIBLE TO MAKE URBAN RAIL SYSTEMS MORE SUCCESSFUL?

One of the major elements in the success of urban rail systems is the strong co-ordination of urban planning and transport planning; however, it is evident that policy co-ordination is very difficult to achieve in the fragmented planning and contemporary local government structure. Thus, it could be argued that urban rail systems will never be successful, so should not be built at all. However, there is still a very real need for an effective alternative to the car, and in spite of the finding that urban rail systems are not always as effective as expected, there still exists a substantial political interest in building urban rail systems, particularly light rail systems. Hence, investment in urban rail is likely to continue in the future. Considering the cost incurred in the development of these systems, making them successful remains a major challenge.

There is another reason why it is worthwhile analysing urban rail systems: studies of urban rail systems have shown that in spite of unsuccessful examples, there have been some very successful systems too, and these were built under similar conditions in terms of local government structure. There are two implications of this finding. First, there certainly are other factors in addition to planning co-ordination that affects the success of urban rail systems, and if more emphasis is given to these factors and to ways of controlling them, urban rail systems can be made more successful. Secondly, the existence of successful systems in inappropriate local government settings implies that there may be alternative mechanisms for providing co-ordination between transport and urban planning. These two assumptions are worth examining since they can lead to a better understanding of the factors that make urban rail systems successful or unsuccessful.

2.8 CONCLUSION

This study aims to explore ways of making urban rail systems more successful in spite of the contemporary local government structures that seem to impede success. The research is aimed at developing a better understanding of the factors that influence the performance of urban rail systems, with the underlying purpose of preparing a planning framework which can help to control these factors and help planners to develop successful urban rail systems. The planning framework, which will be developed throughout the study, can best be described as a policy-based approach to urban rail system planning. While the overall purpose is to explore all the factors that may influence success, a special focus will be on seeking alternative mechanisms of providing and sustaining co-ordination between urban planning and transport planning, which seem not to exist spontaneously within existing local government structures.

3. THEORETICAL FRAMEWORK AND METHODOLOGY

3.1 INTRODUCTION

This research is aimed at developing a policy-based framework for urban rail system planning, which might help planners and operators to maximise the success of their urban rail systems. The next section summarises the theoretical background for developing a planning framework, by listing the aims and objectives of the research, and identifying the factors that may affect the success of urban rail systems. Discussion of the theoretical framework of the study is followed by an introduction to the research methodology.

3.2 THEORETICAL FRAMEWORK

3.2.1 Aims and objectives of the research

The main aim of the research is to develop a methodology for measuring the success of urban rail systems, identifying the factors behind their success, and advising planners and operators how to enhance success. It is planned to develop a planning framework, which can incorporate the factors that influence success, with a special focus on exploring alternative mechanisms for enhancing the co-ordination between urban planning and transport planning. Planning co-ordination, as discussed in the previous chapter, plays a very important role in the success of urban rail systems; however, it does not seem to exist spontaneously within the existing local government structure.

The starting point of this research was the increasing amount of urban rail investment world-wide in spite of evidence that few of the new generation urban rail systems have been successful. In particular, an increasing amount of urban rail investment in the metropolitan cities of Turkey was a motive behind the research. It is believed that a better understanding of the factors that affect the performance of urban rail systems will contribute to the urban rail planning process in Turkey. While the product of the research will be applied to the new systems in Turkey, it will be designed to be applicable to medium sized cities world-wide that are planning, constructing, or operating urban rail systems. In addition to Turkish systems, the application of the planning framework will be demonstrated on two British systems that have recently opened for service.

Within this framework, the primary objectives of the research are as follows:

- To provide a better understanding of the factors that make urban rail systems successful.

- To explore alternative ways of providing and sustaining co-ordination between transport and urban planning.

- To establish mechanisms for influencing the factors that affect the success of urban rail systems with the underlying purpose of making them more successful.

- To design a planning framework which incorporates the findings of the analysis and can help urban rail system planners and operators to maximise the success of their systems, and enhance the co-ordination between transport and urban planning.

- To demonstrate the validity of the planning framework.

- To apply the framework to new British and Turkish urban rail systems, and identify ways in which the urban rail planning process in these countries can be improved.

The main product of the research will be the planning framework. The framework will be designed to be used for two purposes. First, it will predict how successful new urban rail systems will be. Second, it will help make recommendations on how the success of the systems can be enhanced.

3.2.2 Identifying the factors that may affect success

The starting point for the process of planning a framework is to identify all factors that may be influential on the success of urban rail systems. To be able to include all possible factors, the study must cover all stages of developing an urban rail system: from the decision of whether or not to build an urban rail system, to decisions of how to operate the system. Before listing and categorising the factors, however, it is important to define 'success' because the way 'a successful urban rail system' is defined plays an inevitable role in identifying the factors that may affect success.

3.2.2.1 Defining success

In this study, success is defined in terms of the fulfilment of expectations. New urban rail systems are expected to attain certain objectives, which usually justify their being developed. Previous research on new urban rail systems (Fouracre et al, 1990; Walmsley and Perrett, 1992; ECMT, 1994; Simpson, 1994; Mackett and Edwards, 1996), which were described in Section 2.3.2 of Chapter 2, revealed a comprehensive set of objectives that most urban rail systems were developed to fulfil. In addition to previous research, interviews made with planners for this research revealed some objectives to be particularly important. Combining them with the data from previous research, five main objectives are identified.

The first objective for developing urban rail systems is to attain a high patronage, or at least match the forecast patronage on the system. Planners do not often include this objective among their list; however, it is important to analyse the attainment of this objective not only because it helps attain other objectives, but also because the success of urban rail systems are often measured by patronage indicators.

The second objective of urban rail systems is to be cost-effective in terms of building the systems, as well as operating them.

The third objective for investing in urban rail systems is to increase public transport usage. Improving the service quality of public transport is a very common justification for urban rail investments. The improvement, which it is believed will be realised by the introduction of an urban rail system, is anticipated to help enhance the patronage on public transport systems.

The fourth objective is to prevent or solve the problems of traffic congestion and environmental pollution. Three sub-objectives can be identified: to reduce growth in car usage; to relieve traffic congestion, and to improve air quality. The first two objectives appear to be similar; however, it is anticipated that an urban rail investment which does not result in a reduction in car usage may nevertheless result in a reduction in traffic congestion, as a result of certain factors, such as its alignment or a pedestrianisation project. It may be argued that such reductions in traffic congestion may only be local and at the expense of other parts of the city. These issues must be considered during the analysis. As a result, reducing growth in car usage and relieving car traffic are treated as separate sub-objectives.

Finally, the fifth objective is to improve the land-use and urban growth patterns. It refers to sub-objectives, such as to stimulate development at city centres; to stimulate development at economically declining areas, to improve the pattern of urban growth by reducing car-oriented sprawl, and to improve the image of the city. When the performance analysis is conducted, one of them, improving the image of the city, is excluded from the list. This is because it is very difficult to determine indicators to measure whether or not this objective is attained. It is an extremely subjective, and a very debatable issue.

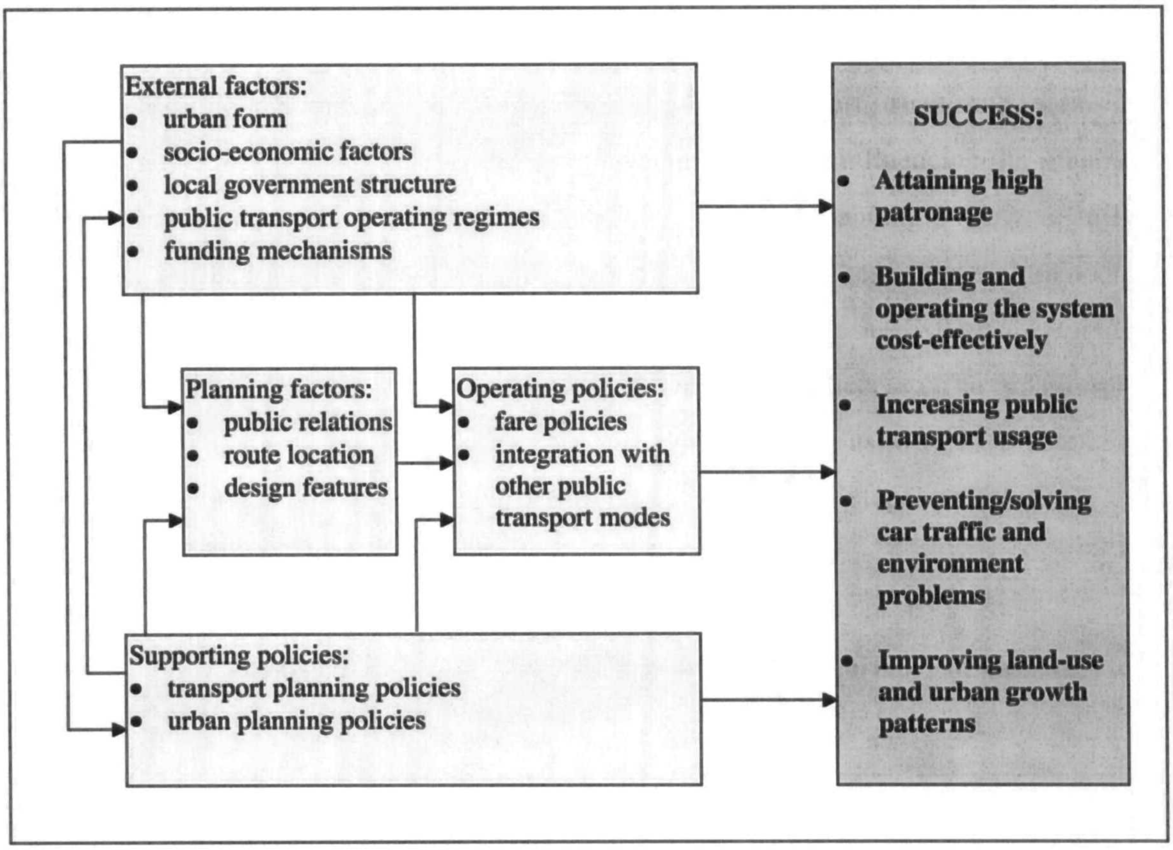
The success of urban rail systems will be measured against these five objectives. Systems will be regarded as successful if they attain the objectives. Section 3.3.4 provides more detailed information on the methodology of the success analysis.

3.2.2.2 Identifying the factors

Four main sets of factors which can influence the level of success can be identified. These are believed to cover the whole process of developing an urban rail system: external factors, planning factors, operating policies, and supporting policies. The first set of factors, external factors, refers to the urban form, socio-economic factors, local government structure, public transport operating regimes, and the funding mechanisms.

The second set of factors is the planning factors: public relations, locations of routes, and the design features of systems, such as technology. The third set of factors relates to the operation of the urban rail systems: operating policies, such as integration with other public transport modes and fare policies, may affect the success of urban rail systems. The fourth set covers policies that can be implemented to support urban rail systems and enhance their success. These can be transport planning policies influencing the urban rail system as well as other transport modes in the city, or urban planning policies regarding city plans and actions that may affect the urban rail system. These four sets of factors cover the process of developing urban rail systems as well as various external factors that may affect their planning, operation, and eventually their success. The relationships between these factors and the success of urban rail systems, as well as the relations amongst the factors, both of which are hypothetical at this stage of the study, are illustrated in Figure 3.1.

Figure 3.1 A model of the factors that influence the success of urban rail systems



There may be other ways of listing and categorising the factors that are likely to influence the performance of urban rail systems. It is also possible that after analysing these factors in depth, some of them may be eliminated, or some new factors added. This list provides a starting point to the design of the planning framework. It is hypothetical at this stage, and its validity has yet to be verified.

The way success is defined also influenced the process of identifying the factors. The factors listed above are believed to have effects on the attainment of the objectives. In addition, some of them may also influence the level of co-ordination between urban planning and transport planning, and hence affect success. They are described in more detail below.

External factors

Urban form, socio-economic factors, local government structure, public transport operating regimes, and funding mechanisms are factors external to the planning of urban systems. They will be accepted in the study as the inputs to the planning process.

Urban form refers to the physical factors, such as population density, the pattern of urban development, and the location of employment and retail centres. Urban form may affect the attainment of most objectives. It is very likely to influence the patronage of urban rail systems, as well as the patronage of entire public transport systems. Urban form may also determine whether operating an urban rail system in a particular urban area can be cost-effective. In addition, urban form may have effects on the attainment of land-use objectives. If the urban form is very unsuitable for public transport usage, it may be difficult to change the pattern of urban growth merely with an urban rail investment.

The socio-economic conditions of the citizens too, may affect the attainment of some objectives. For example, income and car ownership levels may influence the patronage. They may determine whether people will be willing to give up their cars and use the new system. Hence, these factors can affect the attainment of objectives regarding public transport and car traffic.

The structure of local governments in a city may also affect the success of urban rail systems. It may affect the level of co-ordination between urban and transport planning, which, in Chapter 2, was discussed as one of the main factors that influences the success of urban rail systems.

In addition to local government structure, public transport operating regimes, such as the private or public operation of urban rail systems, and the regulatory issues regarding other public transport systems can be influential on success since they can affect operating characteristics, and may therefore influence the cost-effectiveness, system patronage, and ultimately the viability of the entire public transport system.

Funding mechanisms are another factor that is regarded here as external to the planning of the systems. This is because they are determined mainly by national and local government fiscal structures as well as fiscal policies regarding transport investments. Since, within the scope of this study, it is not intended to propose mechanisms of funding, they will be accepted as inputs to the planning process.

The way an urban rail system is funded is likely to shape the design, scale, or location of the system, all of which may influence the patronage. In addition to the funding of the capital cost, the funding of the operating cost may be important. Whether the operation of the system is subsidised would have effects on the cost-effectiveness of operation. Besides, subsidy may influence the service standards of the system: for example, it may be easier, financially, to increase service frequency if the operation is subsidised. Service standards, such as frequency, are likely to affect the patronage.

Planning factors

Planning factors include public relations, route location, and design features. While the last two factors refer to decisions regarding the physical planning of urban rail systems, public relations refer to the way that these decisions are accepted by the citizens, and the way their reactions are handled.

The way public relations are handled and the way public participation is provided in the design of the system can be very important in shaping the citizens' attitude towards the investment. Negative attitudes to the system, which may result from a poorly handled process of public participation, may affect the patronage of the urban rail system.

The location of the routes is another important factor. The location of the system would certainly be important for attaining a high level of patronage. It may also be influential on the attainment of other objectives. For example, as Gomez-Ibanez (1985) argues, if the urban rail investment results in a significant improvement in the accessibility of the urban area, it may increase the public transport usage, and reduce car traffic, and hence improve the air quality. If the system attains a high patronage as a result of its suitable location, it would probably operate in a cost-effective way. In addition, the location of the system may be important for being able to direct urban growth, and change the pattern of urban growth. What type of route locations would be 'suitable' for the success of urban rail systems is to be explored throughout the research.

The design features of an urban rail system, such as its technology, scale, and segregation from street, can also be expected to influence its performance. Technology can affect the image of the system; therefore, it may affect its attraction, hence its patronage and its ability to attract car users. Technology may also affect the extent the new system can be integrated into the overall public transport network, therefore affect operating characteristics and the attainment of the objective of increasing public transport patronage. The cost-effectiveness of the operation and the attainment of air quality objective can also be affected by the technology of the system. In addition, design attributes may affect the attainment of land-use and development-related objectives. For example, a fully segregated system can provide a fast and reliable service to residential areas, and therefore may influence the direction of suburban growth.

Operating policies

Operating policies include the frequency of service, the fares, the fare systems (zonal or flat fare), and the integration of fares with other public transport modes. All these factors are likely to influence the attraction of urban rail systems, and therefore would affect the patronage, and may be influential on helping reduce or prevent car traffic. Operating characteristics, particularly fare-related policies, are also likely to affect the profitability, hence the cost-effectiveness of urban rail systems. In addition, they can be expected to influence the attainment of some of the land-use objectives. For example, high service frequency may be a factor that can stimulate development in city centres, or in declining areas.

Supporting policies

The fourth set of factors is the policies that may enhance the success of urban rail systems. Two types of policies can be identified: transport planning policies and urban planning policies. Transport planning policies include policies that relate to the operation and management of other transport modes in the city in relation to the new urban rail system, for example policies about car parking and policies about other public transport modes in the city. These can affect the success of systems, and particularly the attainment of objectives regarding system patronage, public transport usage, and car traffic. Transport policies also refer to some policies regarding the planning of the urban rail system. For example, planning the urban rail system in a way that is most compatible with the urban development strategies of the city may be a transport policy which would influence the planning of the system, its route selection, and as a result, its patronage. This latter type of transport policies may also help improve the level of co-ordination between transport and urban plans. Therefore, they may be consequential on the attainment of land-use objectives too.

Urban planning policies relate to actions and plans that would most likely be the responsibility of a municipality or a metropolitan planning agency. These policies include adapting urban plans to the urban rail investment, and increasing density allowances along the system, so that the population along the rail corridor increases. Such policies would directly help the attainment of land-use related objectives, and also indirectly contribute to the attainment of others.

An important point about transport and urban planning policies is that, although they are referred here as supporting policies, there may be some policies which may hinder the success of urban rail systems. For example, an urban planning policy which conflicts with the urban rail system may affect the ability of the system in attaining its land-use objectives as well as other objectives.

The four sets of factors described above are likely to influence the success of urban rail systems. In addition to their possible links with the success of systems, there are possible links amongst them. For example, the local government structure may affect the supporting policies, particularly the co-ordination between policies. Public transport operating regimes may affect the operating policies. The funding sources may affect the design features, such as technology, while issues of subsidy are very likely to influence the operating characteristics. Transport policies may also affect the operation of a system, and the selection of routes. Urban planning policies too can have effects on other factors, particularly on urban form.

As a result, it is assumed that the four sets of factors listed above influence the success of urban rail systems. What their effects are, and how they can be controlled are to be addressed throughout the research. The following section introduces the methodology of this research, which will be used to answer these research questions.

3.3 METHODOLOGY OF RESEARCH

3.3.1 An overview of the methods used in the research

The main focus of the research is on qualitative factors, as described above. Physical, economical, social, political factors as well as planning and operational factors are analysed throughout the study. It is important to adopt a methodology that can represent the effects of these factors on the success of urban rail systems. Hence, it is essential to quantify the qualitative data in order to carry out the comparisons. In developing the planning framework, techniques are used to represent numerically the factors that contribute to the success of the systems. As a result, the methodology adopted integrates quantitative and qualitative techniques: quantitative techniques are used since they help make comparison, but the research retains its qualitative approach since it deals with social, economic, and political factors.

The development of the planning framework is based on comparative analysis to a certain extent. Comparison of different urban rail experiences can reveal the factors that are important for the success of urban rail systems. Differences in the planning process may explain the differences in the level of success.

The research must include both successful and unsuccessful systems because the aim is not only to identify the factors that contribute to success, but also to identify the factors that hinder success. Furthermore, it is necessary to have differences in the level of success of systems, so that these differences can be explained by the differences in the planning background and planning processes of urban rail systems.

The comparative analysis, based on the case studies, aims to identify the factors that influence success, as well as ways of controlling them and enhancing the success. Through the generalisation of the findings, a planning framework will be produced. To verify that the generalisations are correct, the product, that is the planning framework, will be tested on a number of other urban rail systems. According to the results of these tests, the framework will be either refined, or verified to be accurate in establishing links between the success of urban rail systems and various factors regarding their planning.

Finally, the framework will be demonstrated on two British cities, Birmingham and Croydon, and three Turkish metropolitan cities, Ankara, Adana, and Izmir, that have recently developed urban rail systems. The aim will be to predict the success of these systems, and to explore ways of enhancing their success.

3.3.2 Case study selection

The underlying principle in case study selection is to select cases which are comparable to each other to a certain extent so that the analysis can focus on the differences in the planning processes of the systems. In addition, it is important to select urban rail systems that are comparable to those which are being developed in the metropolitan cities of Turkey since it is planned to apply the product of the study to Turkish systems.

For the selection of the case studies, all urban rail systems, world-wide, that are listed by Bushell (1997) and Taplin (2000) have been taken. Selection among these systems was made in three steps, at each of which, some systems were eliminated according to specific criteria.

The first criterion of selection was based on system characteristics. Since new generation systems are the focus of the study, systems that have been built since 1970 were selected. To be able to detect impact on both transport and land-use, very young systems had to be eliminated; therefore, systems that opened before 1995 were chosen. In addition to the age of systems, physical characteristics were also important. Systems that were longer than 20 km, smaller than 70 km [2], and those that had less than 5 routes were selected, so that some of the differences due to scale could be eliminated. Since the focus is on urban rail systems, regional metros, such as those in Amsterdam from Netherlands, and Recife and Porto Allegre from Brazil, were also eliminated.

Secondly, urban characteristics were considered. It was desirable to select urban rail systems that were built in cities with a range of urban characteristics because different urban settings may be one of the reasons for differences in success. However, it is important to eliminate differences that may result from major population variations. For example, it would be misleading to compare a very small urban area with a very large metropolitan city, such as Los Angeles or London. Furthermore, it is desirable to analyse cities which have population similar to the Turkish metropolitan cities that will be observed. Medium size cities are more appropriate for the scope of the study. As a result, all urban rail systems world-wide, that serve cities with population less than 500,000 or more than 3 million have been eliminated.

The third criterion of selection had a political basis: selecting systems that were built within similar political systems was believed to be important in order to eliminate some of the differences that would be irrelevant to this study. For example, it is evident that planning approaches in former socialist countries would be very different from those in the rest of the world. The observation and evaluation of these differences are not within the scope of this study.

After systems have been eliminated according to the above criteria, there remained 6 systems from Western Europe, 11 systems from North America, and 3 systems from the rest of the world, that were appropriate for the study. These were Wien Metro from Austria; Lyon and Lille Metro from France; Tyne and Wear Metro, Manchester LRT, and Sheffield LRT from Britain; Calgary LRT, Edmonton LRT, and Vancouver SkyTrain from Canada; Atlanta Metro, Miami Metro, Baltimore Metro and LRT, Portland LRT, Sacramento LRT, San Diego LRT, San Jose LRT, and St Louis LRT

---

[2] At the stage of selecting the case studies, San Diego Trolley was 65 km, and therefore fulfilled the criterion. The patronage and cost-effectiveness analysis, however, is based on its length in 1998, which was 80 km: a new line was added to the network in November 1997.

from the USA; Kobe Metro and Sapporo Metro from Japan; and Tunis LRT from Tunisia.

Selection among these systems was determined by three issues. The first was a practical one. Funding was obtained for a visit to collect primary data on North American systems. In addition to North American ones, British systems also appeared as appropriate both because of the convenience of conducting interviews with the experts in the English language, and because the research is based in England. Hence, it was decided to concentrate on North American and British systems for practical reasons. The second issue was the willingness to co-operate of the planners and operators of some of the systems in the United States, Canada, and England. The third issue involved the identification of the most suitable systems from literature review. From this, the relative success of each system and the different planning tools that each city had employed in relation to their new rail system were identified. The aim was to include both successful and unsuccessful systems, and those that implemented different and innovative policies to support the systems, whether or not successful.

Taking these concerns into consideration, it was worthwhile to study the following systems: Miami Metrorail, St Louis MetroLink, San Diego Trolley, and Sacramento Light Rail, from the United States; Vancouver SkyTrain from Canada; Tyne and Wear Metro, Manchester Metrolink, and Sheffield Supertram, from Britain.

3.3.3 Methods of data collection

Four main methods of data collection have been used: interviews, fieldwork, documents provided by planners and operators of the systems, and previous research on the selected urban rail systems.

Interviews are the most valuable data source for the collection of data on the planning background and planning process of the systems. For the North American case studies, a field trip has been made in June 1997. Among the British cases, Manchester was visited in March 1998, and Sheffield and Newcastle in August 1998. In each city, interviews have been conducted with experts involved in the planning of the systems, in the funding arrangements for the systems, in their marketing and customer relations, and in their operation. In addition, interviews were conducted with city planners in municipalities and in metropolitan planning agencies (in American cities and in Vancouver, in Canada; there are no metropolitan governments in England). Furthermore, universities in these cities were visited and interviews were conducted with researchers who are involved in the monitoring of the systems, or working on impact studies of the systems.

The interviews consisted of six parts. The first part included questions for the experts involved in the planning of systems. These questions related to both the planning background of the systems and their design. Information about transport policies implemented to support the systems, and the impact of the systems on urban transport were also obtained. The second part of the interview which related to financial matters was addressed to experts involved in the funding of the investment. The third part of the interview included questions about public participation in planning, public response to the projects, public relations, and marketing and advertising of the systems. The fourth part comprised questions for city planners from municipalities or metropolitan planning agencies. Questions covered their involvement in the planning of the urban rail systems and policies they implemented to support the systems. The fifth part of the interview related to the impact of systems on land-use and urban development. Both city planners in the municipalities and metropolitan planning agencies, and researchers in universities that were involved in the monitoring of the systems were interviewed. The sixth part of the interview was about the operation of the systems, and was directed to the operators.

Documents provided by experts in the cities visited have been particularly helpful in obtaining data needed to measure the success of urban rail systems. In addition, fieldwork made under the guidance of experts who were involved in the monitoring or impact studies have contributed to the measurement of performance of systems in the attainment of land-use objectives. In addition, previous research (Fullerton and Openshaw, 1985; Gomez-Ibanez, 1985; Johnston et al, 1988; Pickrell, 1990, 1992; Walmsley and Perrett, 1992; Davoudi et al, 1993; Heseltine and Mulley, 1993; Rowley, 1995; Warren, 1995; Knowles, 1994, 1996; TRB, 1996a; Haywood, 1998a, 1998b, 1999; Senior, 1999) on the performance of the selected systems have also been used.

Throughout the research, annual performance data have been updated because the completion of research took place three years after the field trip to North America, and two years after the trip to the British cities. Updating was carried out through correspondence with the experts in these cities, as well as documents involving statistical data published in England (such as DETR, 1998b, 1999a, 1999b) and the world-wide-web sites on statistical data about the US systems and cities (see Federal Transit Administration, 1999, 2000; US Census Bureau, 1999).

3.3.4 Methods of data analysis

Both quantitative and qualitative analysis of data are used in the research. The comparison of the planning processes requires qualitative analysis while for the analysis of the success of the systems, both methods are used, depending on the type of objective that is being observed.

The success of systems is measured by their performance in attaining the five objectives that were listed in Section 3.2.2.1. The performance of systems in attaining the objectives is measured by using indicators. Three indicators are used for each objective to observe the performance of the systems in the relevant area. The indicators are listed in Table 3.1.

Table 3.1 Indicators observed for measuring the success of systems in attaining their objectives

Objectives	Indicators observed
Attaining high patronage	Comparison of patronage with that forecast Patronage per route kilometre Vehicle load (number of passengers per vehicle)
Building and operating the system cost-effectively	Capital cost (annualised) per passenger Operating cost per passenger Farebox recovery ratio (ratio of operating cost to fare revenues)
Increasing public transport usage	Modal share of public transport before and after the urban rail system Bus patronage usage before and after the urban rail system The patronage trends of the urban rail system
Preventing/solving environmental and traffic problems	Car usage trends before and after the opening of the urban rail system Traffic congestion levels before and after the opening of the urban rail system Air quality levels before and after the opening of the urban rail system
Improving the land-use and urban growth patterns	New development in the city centre after the opening of the urban rail system New development in declining areas after the opening of the urban rail system Changes in the pattern of urban growth after the opening of the urban rail system

For the objectives regarding car traffic and land-use, the choice of indicators is quite explicit since they are based on sub-objectives: the fulfilment of them can help attain the main objective. For the other objectives, on the other hand, the choice of indicators is very important since it may affect the results of the success analysis. There are two factors that affect the choice of indicators. Availability of data is one of them. Indicators for which data are not available cannot be included. In addition, there is a preference for indicators for which data on other systems are also available so that performance of the case studies can be compared with the performance of other systems. The second factor which shaped the choice of indicators is previous research. There are some criteria which are used very frequently by other researchers, and they have almost become a standard way of measuring success. For example, comparison of actual and forecast patronage, comparison of capital and operating cost with patronage, and the analysis of farebox recovery ratio are widely used in other comparative research on urban rail systems (see Fouracre et al, 1990; Pickrell, 1990, 1992; Parkinson, 1992; Walmsley and Perrett, 1992; Dunphy, 1997; Mackett and Edwards, 1998).

On the other hand, it is important to ensure that the overall result of the performance analysis does not change when other indicators are used. Therefore, throughout the analysis, other indicators which are not included in the above list will also be observed in order to avoid any bias that may be built in the study as a result of the choice of indicators.

It was mentioned above that for some indicators, comparisons with other urban rail systems that are not observed here will be made. When dealing with numerical indicators, such as indicators of patronage and cost-effectiveness, it is difficult to determine which values indicate success, in other words which value represents a breaking point between successful and unsuccessful systems. For this reason, other new generation urban rail systems from the United States, Canada[3], and Europe have been analysed, and the average of their performances has been used for determining the success of the case

[3] Although new generation systems are regarded in this research to be those built since 1970, the metros in Toronto and Montreal which opened in 1954 and 1966, respectively, are also included in order to compare Vancouver SkyTrain with Canadian metros, because the system has the characteristics of both metro and light rail, and no other metros opened in Canada more recently than those in Toronto and Montreal.

systems. (The list of the systems used for comparison is presented in the Appendix.) If the performance of a case system is better than the average performance of other systems that were built in the same country (in the case of British systems, comparison is with the average of European systems), then it is regarded as being successful. Unfortunately, it has not been possible to obtain data and calculate the average value for each indicator examined here. Therefore, when data are not available, the success of systems is determined in a relative sense, using the average values of the eight systems observed here.

When measuring the overall success of each system, two methods are used. First, the performance of systems is measured against the five objectives above. The more objectives the urban rail systems attain, the more successful they are. Secondly, the performance of systems in attaining their own objectives is measured. This method is useful in exploring whether or not the expectations of these systems have been met.

The final task in success analysis is exploring the factors that enhanced the success of systems as well as those that hindered success. Links between the background and planning factors of systems and their success will be established throughout the analysis. The findings then will be incorporated in the planning framework, which is the main product of this research.

3.4 CONCLUSION

In this chapter, the conceptual framework of the research and its methodology have been presented. Based on the way 'success' is defined in this study, four sets of factors have been identified as those that are likely to influence the success of systems. Hypothetical links between these factors and the success of urban rail systems have been suggested. These links will be verified throughout the study.

To explore what the real effects of the factors are, case study analysis will be conducted in the following chapters. In Chapter 4, background information on case studies will be presented within the framework of the four sets of factors identified. In Chapter 5, the success of the systems will be measured based on the methodology introduced in this chapter. Throughout the analysis, possible links between success and background factors will be established, and these links will be the basis of developing a planning framework that can enhance the success of urban rail systems.

4. THE CASE STUDIES: COMPARISON OF THEIR PLANNING AND OPERATION

4.1 INTRODUCTION

This chapter provides a comparative analysis of the planning processes and the operation of eight urban rail systems. The term 'planning process' here refers not only to the planning of the systems, but also to the background factors, that is the various external factors which may have affected the planning process and the operation of systems. In addition, there may be planning policies which continue to affect the systems. As a result, the observation will be carried out in four sections: external factors, planning factors, operating policies, and supporting policies.

The urban rail systems that are going to be investigated are presented in Table 4.1. Four of the systems are in the United States, one in Canada, and three in Britain. One of the systems, Miami Metrorail, is a full metro; two of them, Vancouver SkyTrain and Tyne and Wear Metro, are rapid transit systems, that is they use light rail vehicles that run on exclusive tracks and use a third rail for power. The remaining five are light rail systems.

Table 4.1 Systems under investigation

Country	City	Name of system	Type of system	Opening year
United States	Miami	Metrorail	metro	1984
	St Louis	MetroLink	light rail system	1993
	San Diego	Trolley	light rail system	1981
	Sacramento	Light Rail	light rail system	1987
Canada	Vancouver	SkyTrain	light rapid system	1986
Britain	Newcastle upon Tyne	Tyne and Wear Metro	light rapid system	1980
	Manchester	Metrolink	light rail system	1992
	Sheffield	Supertram	light rail system	1994

Note: Tyne and Wear Metro is often referred as being located in Newcastle upon Tyne although it serves other towns in the Tyne and Wear conurbation. Throughout the research, both Newcastle upon Tyne and Tyne and Wear are used to refer to the location of the system.

All eight of the systems were opened in or after 1980. The oldest ones are Tyne and Wear Metro and San Diego Trolley. Light rail systems in Manchester, St Louis, and Sheffield opened most recently.

4.2 EXTERNAL FACTORS

4.2.1 Urban form

Urban form refers to the population and physical characteristics of the urban areas served by urban rail systems. It will be remembered that one of the criteria for selecting case studies was the population of the cities that the systems served. Cities with populations between 500,000 and 3 millions were selected for reasons which were described in Section 3.3.2. The way population is spread over the urban area varies between cities. The American cities, as one might expect, are relatively low density, as shown in Table 4.2. Population and housing densities in Sacramento and St Louis, in particular, are very low. Canadian cities have generally higher densities of population compared to American cities (Mercer, 1999); indeed, the population and housing density in Vancouver is higher than the American cities, and not much lower than one of the British ones. Among the British cities, Sheffield has a lower average density for both population and housing. Newcastle upon Tyne is the city with the highest densities, followed by Manchester.

In addition to urban density, factors related to the Central Business District (CBD) have also been observed. It has not been possible to obtain data on the amount of office floorspace in each city, but information about the location of employment and retail activities has been obtained. The economic vitality of the CBD is also among the factors observed in this study, but it is included under socio-economic factors in the next section.

In Miami, employment and retail centres are scattered across the urban areas. The city centre is only one of many areas where businesses and retail are located. The strongest growth in office development is in the western part of the city, around Miami International Airport. In addition to the airport area, there is a new and growing office centre, Brickell, adjacent to the CBD; however, the CBD has not benefited from the growth of the Brickell office centre. On the contrary, the growth of Brickell may be at the expense of the CBD.

Table 4.2 Urban form in the eight cities

	Population	Population density (persons per km^2)	Housing density (dwellings per km^2)	Location of employment and retail	Dominant urban form
Miami	1,937,094	412	153	CBD and many other locations	grid-iron
St Louis	2,444,099	185	73	CBD and few other locations	radial corridors and grid-iron
San Diego	2,498,016	244	87	mainly CBD	grid-iron
Sacramento	1,481,102	124	46	mainly CBD	grid-iron
Vancouver	1,800,000	706	249	mainly CBD	radial corridors
Newcastle upon Tyne	1,095,152	2,039	881	CBD and few other locations	radial corridors
Manchester	2,499,441	1,943	816	mainly CBD	radial corridors
Sheffield	1,262,630	810	338	CBD and few other locations	radial corridors

Source: Great Britain Office for National Statistics (1998a); Federal Transit Administration (1999); GVRD (1999); US Census Bureau (1999).

Note: Calculation of the population and housing density of urban areas may be affected by the way urban boundaries are defined. Definitions used here are those adopted by the Federal Transit Administration in the US; Great Britain Office for National Statistics in the UK; and GVRD (1999) in Vancouver, Canada.

There are fewer employment and retail locations in St Louis than in Miami. The city centre is one of them; however, there is increasing competition from other office and retail centres. San Diego, Sacramento and Vancouver are different from the rest of the cities in that their city centres are the main location for business and retail, with very weak competition from other centres. In San Diego, the city centre is one of the main locations for business and retail, and it has become increasingly powerful with the help of the city centre redevelopment project. Sacramento is the capital of the State of California. State buildings, which are located at the CBD, make the central area attractive for office development: most new office and hotel buildings take place in the city centre (Walmsley and Perrett, 1992). In terms of retail, however, competition from out-of-town retail centres is increasing. As for Vancouver, the city centre has always been, and still remains, the most attractive centre for business, office, retail, and leisure. The attraction of the CBD as an economic centre has grown to the extent that it has started to cause problems, such as overcrowding, environmental degradation, and traffic congestion. Over the past decades, the local authorities have been pursuing measures to decentralise commercial activities to sub-centres (see for example, GVRD, 1976; GVRD, 1996).

Among the British cities, in Manchester, the city centre remains one of the main locations for business and retail development although there is competition from out-of-town office and retail centres. The city centre of Newcastle upon Tyne has become a very important regional retail centre, particularly after the city centre redevelopment project in the early 1980s. Employment, on the other hand, is located in areas outside the city centre, mostly in industrial sites. Moreover, there are new areas of retail and office development, and these are threatening the city centre. As for the city centre of Sheffield, it is also one of the important locations for office and retail developments; however, out-of-town retail centres have been developed in the past years, and these centres have become much more attractive compared to the city centre.

The urban form in the American cities is mostly grid-iron street patterns while the pattern of new growth is dominantly urban sprawl. Only in St Louis, has the historical growth of the city followed some radial corridors; however, rapid suburbanisation is the current trend, and it takes the form of urban sprawl. Both Vancouver and the British cities have radial corridors along which the cities have grown. However, the current growth trends, which are very much car-oriented, result in urban sprawl.

4.2.2 Socio-economic factors

The overall economy of the eight cities is observed under this heading. It will be remembered from Chapter 2 that many critics have argued that economic conditions may affect the performance of the systems. The observation involves noting the general economic trends in relation to the vitality of the central areas since an economically strong and affluent city centre can contribute to the patronage of an urban rail system that provides access to the city centre. The income and car ownership levels of citizens, and public transport usage in the urban areas will be examined in addition to the general trends, since these factors may affect the patronage of new urban rail systems.

The American cities observed here are prosperous, apart from St Louis. St Louis is often referred as one of the most distressed cities of the United States (Checkoway, 1985).

Between 1950 and 1980, its population decreased by almost 50%, the largest percentage decline of any major city in the United States; in the 1970s about 58,000 jobs were lost with the closure of several manufacturing firms (Checkoway, 1985). Job growth and business growth are still slow in St Louis compared to other metropolitan cities in the United States (East-West Gateway Co-ordinating Council, 1996). Unemployment and economic decline, particularly in the city centre, have created social problems. Crime has been an important urban problem, particularly in the city centre. The ratio of central city crime to suburban crime is the highest in St Louis compared to other metropolitan cities in the United States (East-West Gateway Co-ordinating Council, 1996).

The other American cities enjoy more favourable economic conditions. In Miami, for example, the city never had a strong industry-based economy, and therefore, it was not affected by the decline of manufacturing. The economy of Miami is mostly based on tourism and international banking, both of which are increasingly profitable industries for the city (Mohl, 1983). The general economy of the city is prosperous; however, there are economically depressed communities and declining urban areas within the city. The CBD is one of these areas: it has been losing businesses and population to out-of-town centres. Economic disparities, income inequalities and racial issues have become important urban problems, which have created a reputation for the city as the crime capital of the nation (Mohl, 1983). Indeed, in 1995, Miami had the highest crime rate of the metropolitan areas in the United States (East-West Gateway Co-ordinating Council, 1996).

The economy of San Diego has been largely based on military activities as well as tourism; therefore, it did not suffer from the decline of traditional manufacturing; however, the city had always suffered from a lack of economic diversity (Corso, 1983). In the recent decades, the regional economic balance in the United States has been changing: southern cities, particularly Californian cities, which have been affected relatively less by the decline of manufacturing, have become the focus for new developments of high-technology industries (Wallace, 1999). San Diego has benefited from these developments to a certain extent. In addition to high technology industries, low technology ones, which are mostly based on a low-paid work-force of Mexican immigrants, have started to grow in San Diego (Wallace, 1999). As a result of these economic developments, San Diego became one of the fastest growing metropolitan areas in the United States. The population grew by 34.1% between 1980 and 1990

(Bourne, 1999). Parallel to the improving economic conditions, the city centre has been going through a comprehensive redevelopment project since the 1970s, which revitalised the city centre. In terms of the economic disparity index, which compares the city centre to other parts of the city, and the crime rate, San Diego has one of the lowest values of the index for metropolitan cities in the United States (East-West Gateway Co-ordinating Council, 1996).

Sacramento is the capital city of California State. Although its economic growth is slow and the city has been much less important compared to other cities in the region (Walmsley and Perrett, 1992), its economy remains strong since the state headquarters are located in the city. The CBD, as a consequence, is strong too.

Vancouver is a prosperous city. Although some parts suffered from the decline of manufacturing, this did not affect the whole city. The city has adapted itself very successfully to the new economic order, particularly by promoting international trade with the far-east countries. Among the Canadian provinces, British Columbia ranks at the top in exports to the Asia Pacific region, and Vancouver, whose port is closer to Asia than any other seaport in the North America, has become the Pacific-Rim capital (Lees, 1999). The CBD of Vancouver has become the office centre of the Pacific-Rim trade.

Turning to the British cities, Manchester is prosperous although some parts of the city suffer from the decline of traditional manufacturing. New high technology industries and office centres generally favour the southern parts of the country; however, Manchester remains the commercial centre of the North of England, and receives substantial investment. Because it is a strong regional centre, its CBD is also strong although there is some decentralisation to out-of-town office centres.

As for Newcastle and Sheffield, the economies of both cities were based on manufacturing. With the changing economic structure, these industries collapsed, and unemployment became a major urban problem. In spite of central government interventions to regenerate the economically depressed areas in these cities, it is hard to claim that the overall economic vitality has been restored. Of the two cities, Newcastle has been in a more advantageous economic position since it was a regional centre; however, new retail and business centres are causing decline in the CBD. Sheffield has never been a strong economic centre. In the region, other cities, such as Manchester and Leeds, have always been commercial centres while Sheffield remained an industrial city. Hence, its CBD has always been very weak. Furthermore, the decentralisation of central activities, particularly of retail, is a current trend which is likely to cause the further decline of the CBD.

The general economic trends in the eight cities are summarised in Table 4.3. The income per capita is also shown as an indicator of the economic situation in the cities. The British cities seem to have lower average income per capita compared to the North American ones. Since currency conversion has been made by using purchasing power parity indexes, allowance has been made for the differences between the economies of the different countries. It is noticeable that the two Californian cities, San Diego and Sacramento, have the highest income levels.

Table 4.3 Economic indicators and urban transport indicators

	State of the economy	Economic vitality of the CBD	Income per capita (£)	Car ownership: cars per household	Annual public transport trips per person (1998)
Miami	prosperous	declining	8,245	1.49	39
St Louis	declining	declining	8,980	1.67	22
San Diego	prosperous	strong	9,764	1.78	30
Sacramento	prosperous	strong	9,275	1.80	19
Vancouver	prosperous	strong	8,474	1.65	126
Newcastle/Tyne	declining	declining	7,601	0.61	179
Manchester	prosperous	strong	7,813	0.81	90
Sheffield	declining	declining	7,431	0.77	121

Sources: US Census Bureau, 1999; Great Britain Office for National Statistics, 1998a, 1998b; Department of the Environment, Transport and the Regions, 1999a, 1999b; GVRD, 1999.
Notes: Income data for US cities is from 1990 census in US; for UK cities data is for 1991; for Vancouver data is for the year 1995, but deflated to the year 1990. All currency conversions are made by using Purchasing Power Parity rates (OECD, 1999).

Car ownership levels appear to reflect the income levels to some extent. In San Diego and Sacramento, where the income per capita is the highest, car ownership levels are also the highest. On the other hand, the significant difference between car ownership levels in North America and Britain cannot be explained merely by differences in income. Car-based urban form, as well as the traditionally low usage of public transport in American cities, must be among the reasons why car ownership levels are so high.

Public transport usage levels are indeed much higher in the British cities. American cities have very low numbers of annual public transport trips per person, as shown in the table. It is remarkable that in Vancouver, where the number of cars per household is as high as in the American cities, public transport usage is also very high: it is comparable to the usage in British cities. The comparison supports the findings of previous research (Goldberg and Mercer, 1986) that Canadian commuters rely less on private transportation than Americans: in early 1980s, 25% of the Canadians commuted by public transport, while the proportion was 13% for the United States. More recent data showed that the difference in public transport usage was still evident (Mercer, 1999).

4.2.3 Local government structure

The way urban areas are governed, and the way urban planning and transport planning are carried out influence the planning of urban rail systems, and therefore may affect their success. This section describes the structure of local government in the United States, Canada, and Britain. The recent structural and political changes in local government as a result of central government policies were discussed in Chapter 2. This section will first describe briefly the effects of central government policies. Then the structure of local government in the three countries will be examined. Finally, local government in the eight case studies will be analysed.

4.2.3.1 Central government policies in recent decades and their effect on local government

In most Western democracies, as discussed in Chapter 2, New Right governments were in power in the 1980s and most of the 1990s. Although other political parties are in power today in some of these countries, the policies of the New Right governments had important impacts on local government, which still continue to affect urban and transport planning.

The New Right governments had radical policies for local government and urban planning. While the policies were quite similar across the countries, their impact varied.

The effects of the New Right policies have been felt most radically in Britain. The Conservative government under Thatcher made a drastic change in local government structure by abolishing metropolitan county councils, and caused a significant loss in local political power by privatising the housing stock of city councils; by passing legislation for the contracting-out of public services that had been provided by local government; by setting limits to the revenue-raising powers of local governments; and by introducing new planning mechanisms and institutions, such as Enterprise Zones and Urban Development Corporations, that were centrally controlled and by-passed local government planning agencies (Parkinson, 1990; Keating, 1991; Pickvance, 1991). Such transformations resulted in a significant reduction in local financial autonomy, as well as reductions in the overall functions and responsibilities of municipalities, which traditionally had more functions than municipalities in the United States and Canada. In addition, policies that favoured privatisation had a substantial impact on the planning tradition, transforming it from a regulationist approach to a corporatist and entrepreneurial one (Taylor, 1998).

The United States, under the Reagan administration, experienced similar New Right policies. For example, funds from the Federal government were cut; however, this did not have a very strong impact on American municipalities because state governments compensated for the decreased municipal income by increasing their own expenditures (Fainstein and Fainstein, 1991; Keating, 1991). Like the Central Government in Britain, the Federal Government in the United States intervened in local planning through specific schemes, such as Enterprise Zones and Urban Development Action Grants. Enterprise Zones, which have been extensively implemented in Britain, failed in the United States since their implementation required the co-operation of state governments: new legislation had to be introduced by state governments who are the main regulators of local conditions (Fainstein and Fainstein, 1991). Enterprise Zones were mainly to be located in states where the Democratic Party was in power, and they did not pass legislation for its implementation. The Urban Development Action Grant (UDAG) programme, on the other hand, was successful. It was introduced in the 1970s, before the Reagan government, who did not abolish the programme. It is claimed in a report by the Department of the Environment (1990) in Britain, that the American UDAG programme developed into one of the most efficient mechanisms ever introduced by the Federal Government to attract private investment in economically declining areas. An important strategy of the programme was that the UDAG would provide subsidies for projects which had a firm commitment of private resources. Perhaps the reason why this scheme was not rejected by the municipalities was that its private-sector oriented strategy did not contradict the planning and development strategies of the municipalities. American municipalities have always been closer to the corporatist and entrepreneurial municipal approach, rather than the strong welfare approach which has been traditional for British municipalities (Wolman, 1990; Keating, 1991; Pickvance and Preteceille, 1991).

Canada, too, has experienced similar New Right policies. Here, municipalities traditionally have very limited powers and very weak local autonomy as opposed to the Provincial governments which are very powerful; therefore, Federal policies in recent years did not target the municipalities but the provincial governments (Hamel and Jalbert, 1991). Nevertheless, the public spending controls that the Federal Government imposed on provinces affected the municipalities because the provinces enforced these controls over them. Even after the Federal controls were lifted, many provinces continued to enforce expenditure-cutting programmes on municipalities (Magnusson, 1990a). Fiscal pressures forced municipalities to adopt entrepreneurial approaches in urban development. However, municipalities in Canada have always been financially weak; therefore, although they have a strong tradition of a regulation-based planning approach, they have also been traditionally engaged in corporatist and entrepreneurial approaches in generating economic development (Magnusson, 1990a; Hamel and Jalbert, 1991; Keating, 1991).

To summarise, the policies of central governments affected the municipalities in different ways in the different countries as a result of the differences in the structures, as well as the cultures, of local government systems. British municipalities are the ones which have been most affected, in terms of both financial and planning powers. American municipalities have been the least affected since the cuts from the Federal Government funds were substituted by increased funds from the State Governments. In addition, promotion of the entrepreneurial approach in planning did not alter the planning style of American municipalities because it was very similar to their traditional planning style. Canadian municipalities were not affected much either. Financial cuts affected them;

however, they were always weak in terms of fiscal powers, and therefore they always used entrepreneurial strategies in planning.

4.2.3.2 Local government in the United States

In the United States, urban areas have a two-tier administrative system. Counties, which are subdivisions of states, exist as the upper tier. Cities, or municipalities, are lower tier governments. In terms of city and regional planning, however, counties are not treated as the upper tier metropolitan government. City Councils, the municipalities, are the only local government unit responsible for urban planning. Most large urban areas consist of several municipalities, the number of which is significantly high compared to the number of municipalities in urban areas in other countries. In 1987, the average number of local governments per metropolitan area was 113 (Mercer, 1999). The fragmented structure of local government requires a metropolitan planning agency to provide co-ordination between the municipalities and produce metropolitan plans and policies. Overall, there have been two main methods of establishing metropolitan government: by modernising county governments and by creating voluntary associations between local governments.

The first method of creating a metropolitan planning agency, by the modernisation of the county government, is implemented either by assigning additional powers to the county incrementally, or by converting the county into a metropolitan government (Zimmerman, 1980, p.50). Collaboration of county and city governments to devolve some of their powers and establish a metropolitan government, as experienced in Portland, can also be included under this category. This type of metropolitan governance can be considered as the upper tier planning government since it is based on a well-established administrative unit. Converting a county government into a metropolitan government is possible only when there is a single county in a metropolitan area whereas most metropolitan areas in the United States cover more than a single-county area. In addition, local authorities rarely agree to devolve their powers to another agency. As a result, there have been very few examples of metropolitan governments created by the modernisation of a county government.

The second mechanism of providing metropolitan governance is through voluntary associations of local governments, that is Council of Governments (COGs). Their main task is to provide co-ordination between planning agencies. They are composed of representatives from municipalities who are free to decide whether and how intensively they will participate (Johnson, 1997). COGs have become the predominant form of metropolitan government in the United States (Hallman, 1977); however, their lack of power makes them inefficient (Zimmerman, 1980; Johnson, 1997). They have less power than the modernised counties in terms of ensuring the implementation of the plans they produce, and in terms of controlling local governments to comply with these plans. Their plans and policies are in most cases in the form of recommendations.

The way metropolitan government is established in a city has implications for the public transport planning agency. When there is a metropolitan county, the transport planning functions are likely to take place within the county. In other cases, a public transport planning agency is generally an independent public body, in most cases a 'special district' which is a single-function government established to solve a specific area-wide problem. This latter organisation of governments represents a highly fragmented one, not only in terms of overall planning, but also in terms of transport planning because there would probably be another agency responsible for highway planning.

4.2.3.3 Local government in Canada

Canada has a federal government system similar to that in the United States; however, there are three significant differences between the two local government systems. First, in Canada, the Provincial Governments, which correspond to the State Governments in the United States, are more powerful than their American counterparts; they have powers to create, reorganise, and even abolish municipalities (Hamel and Jalbert, 1991). As a result, they can be actively involved in local and municipal issues. Secondly, there is significantly less fragmentation of administrative units at the city level, and there are fewer municipalities governing an urban area (Goldberg and Mercer, 1986; Keating, 1991). Thirdly, regional governments corresponding to metropolitan governments have been established in most of the major urban areas since 1953 (Magnusson, 1990a). These governments, which are more powerful than the COGs in the United States, are perhaps a consequence of the power of the provinces because it was the provinces which initiated the establishment of regional governments and created a two-tier local government system (Goldberg and Mercer, 1986).

In terms of planning and local government actions too, there are two important issues that need to be noted for the Canadian governments. First, governments are very active in the local economy. Canadians are willing to tolerate government controls and interventions in markets and in the lives of the citizens (Goldberg and Mercer, 1986; Keating, 1991). Relatively great trust for governments has implications for urban planning: it allows a greater ability to plan and regulate urban development (Goldberg and Mercer, 1986). The second issue concerns municipal politics. Local government politics in Canada are claimed to be non-partisan. Municipalities may be governed by major political parties, but they remain politically inactive in municipal issues; the non-partisan nature of politics has created a 'value-free language of development' in Canadian urban areas (Magnusson, 1990, p.173).

The planning of public transport systems is a function of regional governments although Vancouver SkyTrain has a unique planning background, which will be described in Section 4.3.1.

4.2.3.4 Local government in Britain

In Britain, there has been a single tier local government system in the metropolitan cities since the abolition of metropolitan county councils in 1985. Urban planning is carried out by the municipalities, which are called district councils. Each council prepares a unitary development plan for its own jurisdiction.

Since the abolition of metropolitan county councils, there have been no local government organisations responsible for strategic and comprehensive planning in large urban areas (see the Local Government Act 1985). The Department of the Environment, Transport and the Regions, a central government department, is responsible for preparing regional policy guidance with which the municipalities must comply. As a result, urban strategic planning at the metropolitan level does not exist: instead, regional policy planning is made, but by a central government agency rather than a local or regional government (Cullingworth and Nadin, 1997).

During the late 1980s and the 1990s, there were other planning agencies in addition to the municipalities. These were the aforementioned Urban Development Corporations (UDCs), which were appointed by the Central Government in some of the metropolitan areas in England. These agencies, were set up to implement Central Government policies which were aimed at attracting private capital and encouraging private businesses to redevelop declining areas. UDCs were often responsible for a limited part of the city, where the municipalities lost their planning powers. As a result, the UDC programme created a significant fragmentation in planning in English metropolitan cities. (See Lawless, 1990; Parkinson, 1990, Imrie and Thomas, 1999.)

Strategic planning at the metropolitan level seems to have disappeared after the abolition of the Metropolitan County Councils; however, transport planning at the metropolitan level has been sustained. The Passenger Transport Authorities (PTAs), which produce metropolitan transport plans and policies, and the Passenger Transport Executives (PTEs), which implement them, were established with the Transport Act of 1968. When Metropolitan County Councils were established in 1972, they took over the duties and responsibilities of the PTAs while the PTEs remained as the transport department of the county councils. After the abolition of the county councils, the PTAs were established again, comprising the members of district councils. The PTEs remained as the implementers of the transport plans.

4.2.3.5 Local governments in the eight cities

The local government organisation in the eight cities is summarised in Table 4.4. Among the US case studies, in Miami, the county government was reorganised and converted into a metropolitan government, Metropolitan Dade County, in 1957. In St Louis, San Diego, and Sacramento, on the other hand, metropolitan governance is provided through the Council of Governments: East-West Gateway Co-ordinating Council (EWGCC) in St Louis; San Diego Association of Governments (SANDAG) in San Diego; and Sacramento Area Council of Governments (SACOG) in Sacramento. In Vancouver, there is a metropolitan government, Greater Vancouver Regional District (GVRD), which was established by the Provincial Government as the upper tier local authority.

It is seen in the table that there are no metropolitan governments in the British cities. The planning of the urban rail systems, in fact, dates back to the 1970s and the early 1980s when metropolitan county councils existed; however, among them only Tyne and Wear Metro was constructed by a metropolitan county council. It was also operated by it during its initial years.

Table 4.4 Local government structure in the eight cities

	Metropolitan planning		Urban planning	Public transport planning	
	Upper-tier regional government	Council of governments		Under metropolitan government	As a separate agency
Miami	Metro-Dade County		Municipalities	TSD	
St Louis		EWGCC	Municipalities		Bi-State
San Diego		SANDAG	Municipalities		MTDB
Sacramento		SACOG	Municipalities		RT
Vancouver	GVRD		Municipalities	(GVRD until 1983)	BC Transit
Newcastle/Tyne	-	-	Municipalities+UDCs	N/A	TWPTA
Manchester	-	-	Municipalities+UDCs	N/A	GMPTA
Sheffield	-	-	Municipalities+UDCs	N/A	SYPTA

N/A: not applicable.

As mentioned earlier, there were centrally-appointed temporary planning agencies, the Urban Development Corporations (UDCs), in the British cities in the 1980s and the 1990s. In Tyne and Wear, there was the Tyne and Wear Development Corporation (TWDC) set up to regenerate the areas occupied by the declining marine industry. Not much of the area covered by the TWDC is served by the Metro. In Manchester, there were the Central Manchester Development Corporation (CMDC) and the Trafford Park Development Corporation (TPDC). The former was set up to regenerate the southern parts of the CBD while the latter focused on a declining industrial area, Trafford Park, where the second phase of the Metrolink runs through. The second phase is not included in this study. In Sheffield, Sheffield Development Corporation (SDC) was set up to regenerate the declining industrial area, the Lower Don Valley, where one of the lines of the Supertram runs.

Table 4.4 also presents the public transport planning agencies in the eight cities. In Miami, the agency responsible for public transport planning is called the Transit System

Development Division (TSD), and is under Metropolitan Dade County. In the American cities where metropolitan governance is provided through the COGs, public transport planning agency is a separate agency, often a special district. In St Louis, it is called the Bi-State Development Agency; in San Diego the Metropolitan Transit Development Board (MTDB); and in Sacramento the Regional Transit District (RT). In Vancouver, GVRD was the planner of public transport systems until 1983, when its public transport planning power was taken by the Provincial Government, and transferred to BC Transit, a new agency under the Provincial Government. As a result, SkyTrain was originally planned by the GVRD, but was constructed by the BC Transit.

In the British cities, Passenger Transport Authorities are the public transport planners. Their names are Tyne and Wear Passenger Transport Authority (TWPTA), Greater Manchester Passenger Transport Authority (GMPTA), and South Yorkshire Passenger Transport Authority (SYPTA).

In addition to the planners of the systems, it is also important to note the operators of the systems. They are described in the following section.

4.2.4 Public transport operating regimes

The most important point about the case studies in terms of the operating regimes is the deregulation of buses in the British cities. The operation of buses in Britain outside London was deregulated by the Transport Act of 1985, which came into effect in 1986. Since deregulation, bus services have been provided by companies, public or private, which are not subject to regulations regarding fares or routes. In the metropolitan areas, the Passenger Transport Executives (PTEs) can also provide bus services; they are responsible in particular for securing the provision of services that are considered to be socially necessary. PTEs can also subsidise bus services, but only if the service is not likely to be provided without subsidy by the free market. In both providing services and subsidising services, it is their duty not to inhibit competition. (Transport Act 1985)

In all North American case studies, on the other hand, buses are regulated. They are generally operated by public companies. Furthermore, it is common for both buses and urban rail systems to be operated by the same agency (Hass-Klau and Crampton, 1998).

Detailed information on the operators of the urban rail and bus system in the eight case studies are summarised in Table 4.5.

Table 4.5 Owners and operators of urban rail and bus systems

	Urban rail system		Bus system
	Owner	**Operator**	**Operator**
Miami	Metro-Dade County	TSD	TSD
St Louis	Bi-State Development Agency	Bi-State Development Agency	Bi-State
San Diego	MTDB	SDTI	SDTC
Sacramento	RT	RT	RT
Vancouver	BC Transit	GVTA (BC RTC until 1999)	GVTA (BC Transit)
Newcastle/Tyne	Nexus	Nexus	various companies
Manchester	GMPTE	Serco Metrolink	various companies
Sheffield	SYPTE	StageCoach (SYSL until 1997)	various companies

In Miami, Transit System Development (TSD), which is the public transport planning department of the Metro-Dade, is also the owner and the operator of the Metrorail, Metromover, the city centre section of the rail system, and the buses. In St Louis and Sacramento too, the public transport planning agencies, Bi-State Development Agency and Regional Transit District (RT) respectively, are the owners and operators of the urban rail systems as well as the buses. All three of the agencies are public entities.

It will remembered from the previous section, that San Diego Trolley is planned and constructed by the Metropolitan Transportation Development Board (MTDB), which also owns the system. When the construction of the Trolley was completed, a new agency, San Diego Trolley, Inc. (SDTI), was formed to take over the operation of the system. SDTI is a non-profit public corporation and has to operate the system in compliance with MTDB policies. Buses are run by another non-profit public corporation, San Diego Transit Corporation (SDTC). SDTC is also under MTDB, and is regulated by it.

Vancouver SkyTrain is owned by BC Transit. When the construction of the SkyTrain was completed, BC Rapid Transit Company was established as a branch of BC Transit, to operate the system. BC Rapid Transit Company operated the SkyTrain until April

1999 when the operation of all public transport services in Vancouver was taken over by a new agency, Greater Vancouver Transport Authority (GVTA), also known as TransLink. The GVTA comprises fifteen representatives, three of which are from the Provincial Government. The remaining twelve are appointed by the GVRD from among municipality officials and GVRD directors (GVRD, 2000). The new authority and the dominance of local authorities in its governance implies increased political power on the side of GVRD compared to the traditionally powerful Provincial Government.

The Tyne and Wear Metro is operated by the Passenger Transport Executive which is called Nexus. Buses have been deregulated since 1986. Before the deregulation, for a period of four years, both buses and the Metro were operated by the PTE.

Greater Manchester PTE (GMPTE) owns the Metrolink. The construction and operation of the Metrolink is based on a Design-Build-Operate-Maintain (DBOM) contract. The GMA Group (comprised GEC Alsthom, Mowlem, AMEC) was the consortium who had the contract for the first phase of the Metrolink. For the construction of the second phase, which was again based on a DBOM contract, a private company called Greater Manchester Metro Limited (GMML) was set up, and it took over the operation of the system. Since May 1997 Serco Metrolink, also a private company, has been operating the Metrolink.

Sheffield Supertram is owned by South Yorkshire PTE (SYPTE). The system was built through a Design-Build contract. When the system opened, it was operated by South Yorkshire Supertram Ltd (SYSL) which was a public company. In 1997, SYSL was sold to StageCoach, a private company, as a franchise under an Operate-Maintain contract.

4.2.5 Funding of the systems

In the United States, the decision to build an urban rail system lies with the local authorities as long as they have the available funds and the citizen support to proceed. They are able to build rail systems without having to consult, or receive the approval of, the Federal Government. However, in most cases, local governments do not have sufficient funds; therefore, they need contributions from the Federal Government to the cost of construction of the urban rail systems. When funds are obtained from Federal

Government, they usually comprise up to 80% of the capital cost of the urban rail system (Walmsley and Perrett, 1992; Hass-Klau and Crampton, 1998). The remaining 20% is provided by state funds and local resources.

In Canada, funding is the responsibility of the Provincial Government (Walmsley and Perrett, 1992). In the special case of the Vancouver SkyTrain, as will be discussed in Section 4.3.1, funds were provided by both the Provincial and the Federal Government. There was strong financial support as a result of the SkyTrain's becoming a tool for demonstrating Canadian technology to the world.

In Britain, the responsibility of building an urban rail system lies with the PTAs in metropolitan cities, but they are constrained in their powers to raise funds and invest in public transport (Walmsley and Perrett, 1992). Since the mid-1980s, local resources and the taxing powers of local authorities have been continuously reduced by Central Government, a process which resulted in local authorities being extremely dependent on Central Government funds in their investments. They can raise funds through grants from Central Government, or through loans if the borrowing is authorised by Central Government.

Table 4.6 shows the sources of funding for the eight systems. Among the American systems, San Diego Trolley and Sacramento LRT were built with relatively smaller contributions from Federal Government. San Diego, in particular, has been an example for most new light rail schemes in the United States since the construction of its initial line had relied on only State and local resources. Although the Federal Government contribution increased in later extensions, its most recent extension, the Mission Valley, which is not included in this analysis, was also built by state and local resources (Larwin, 1997a).

In Vancouver, British Columbia, the Provincial Government, was responsible for funding, and because the system became a part of the World Fair in 1986, there was also financial support from the Federal Government.

In England, Tyne and Wear Metro was built mostly with Central Government grants, and with the funds of the local authority. In addition, a contribution of 2% to the total construction cost of the system came from the European Regional Development Fund (Walmsley and Perrett, 1992). The airport extension was different in that construction was carried out through a Design, Build, Operate, Maintain contract.

Table 4.6 Sources of funding for the eight urban rail systems

	Federal / Central Government	State / Provincial Government	Local resources	Other
Miami Metrorail	77%	10%	13%	-
St Louis MetroLink	80%	-	20%	-
San Diego Trolley				
-South Line	9%	45%	46%	-
-East (Euclid Ave)	-	88%	12%	-
-East (El Cajon)	54%	36%	10%	-
-Bayside	-	-	100%	-
Sacramento LRT	56%	18%	25%	1% (private)
Vancouver SkyTrain				
-First phase	7%	93%	-	-
-Second and third extensions	-	100%	-	-
Tyne and Wear Metro				
-First phase	63%	N/A	35%	2%
-Airport extension	-	N/A	DBOM	DBOM
Manchester Metrolink	50%	N/A	50% (DBOM)	
Sheffield Supertram	50%	N/A	42.6%	7.4%

Sources: Documents provided by experts in these cities; interviews with experts in these cities; Walmsley and Perrett, 1992; Hill, 1995; Hellewell, 1991.

For both Manchester Metrolink and Sheffield Supertram, Central Government contributed to the cost of the systems by providing 50% of the costs through a Section 56 Grant (which is based on the guidelines of Section 56 of the Transport Act 1968). In Manchester, the rest of the funding was supplied by the local authorities, from their local tax revenues. The system was built through a Design, Build, Operate, and Maintain contract since that was the condition on which the Central Government made its grant available. As for Sheffield, the other half of the construction cost was provided with no cost to the local community; the Meadowhall shopping centre which is located at the end of the first line, contributed to 2% of the total cost while the European Community IDOPs programme contributed to 5.4% of the cost (Hill, 1995). The remaining 42.6% was provided through loans after the Central Government secured credit approval; these loans were to be paid back by the Central Government (Hill, 1995). Although there was not a pre-condition to the loans and Section 56 Grants, the expectation of the Central Government was that one third of the capital cost would be recovered by selling the Supertram to a private operator after its opening. The sale took place; however, it could be sold only for £1.5 million instead of the expected £80 million (Kevill, 1998).

4.3 PLANNING OF THE SYSTEMS

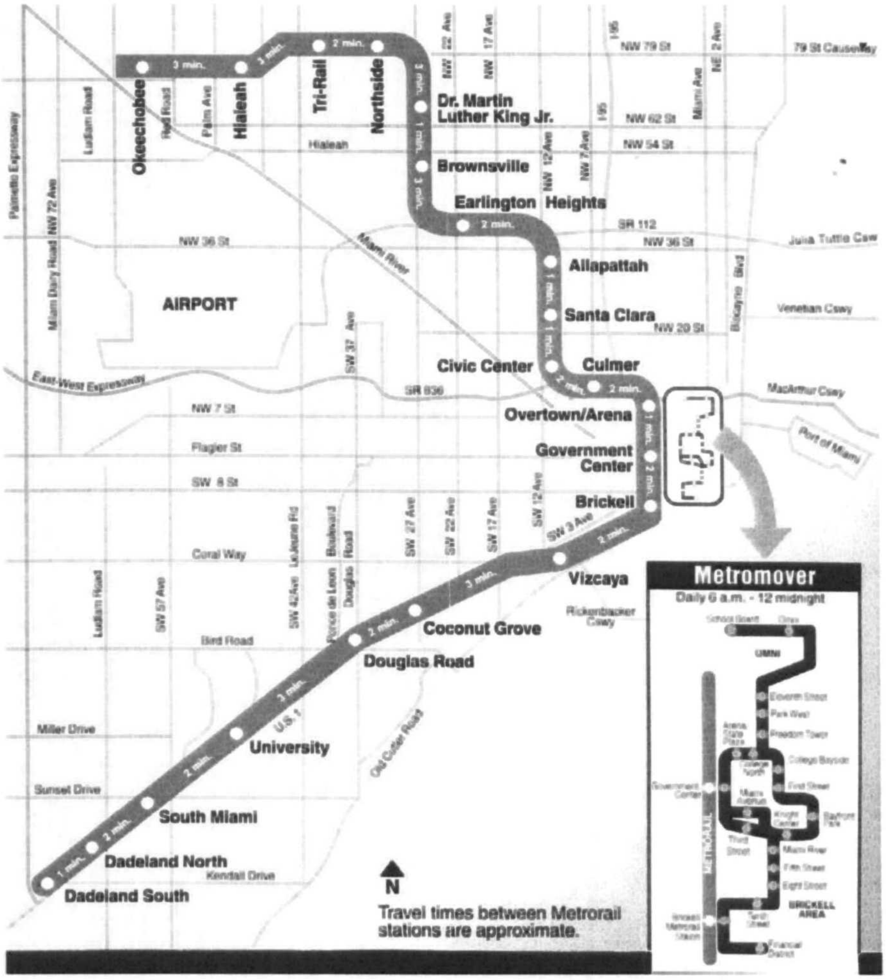
Factors concerned with the planning of urban rail systems may have influences on systems performance. In this section, the planning of the systems are analysed under four headings. Firstly, the background for the development of the systems is described. Reasons for investments, and objectives expected to be met by the investments are summarised. Secondly, public relations throughout the planning and construction of the systems are examined. Thirdly, the routes of the systems are analysed. The reasons for selecting the routes, and characteristics of areas served by the systems are discussed. Finally, the physical attributes of the systems, that is their design features, are observed.

4.3.1 Planning background and objectives for developing the systems

4.3.1.1 Miami Metrorail

The metro project in Miami is based on the 1978 Transportation Master Plan for the year 2000, which proposed the construction of an 87 km rapid transit system with two lines. The first line was planned to extend from south to north via the city centre, while the second line was planned from the city centre towards the west, to Miami International Airport. In 1979, construction started on the first line. The second line had to be postponed after the Reagan government announced cuts in federal spending. The system, Metrorail, opened in 1984. This was followed by the opening of the Metromover in 1986, an automatic people-mover system designed as the city centre section of Miami Metrorail. In 1994, the two extensions of Metromover opened, covering the whole central area. Figure 4.1 shows the system map.

Figure 4.1 Miami Metrorail system map



Source: Map provided by the Metro-Dade Transit Agency, Miami.

The primary objective for developing the Metrorail was to improve the public transport service in the city (Garcia, 1997). Metrorail was anticipated to become a more efficient way of transporting people especially for commuting purposes, compared to private cars. It was believed it would help to relieve traffic congestion at peak times of the day, and eventually improve the air quality in the city. Improving public transport access for low income households at the northern parts of the city, and revitalising these economically depressed areas with the help of urban rail access were also important objectives. In addition, building a high-capacity urban rail system was anticipated to help control urban growth: uncontrolled rapid dispersal of the city and the decline of the city centre were important urban problems.

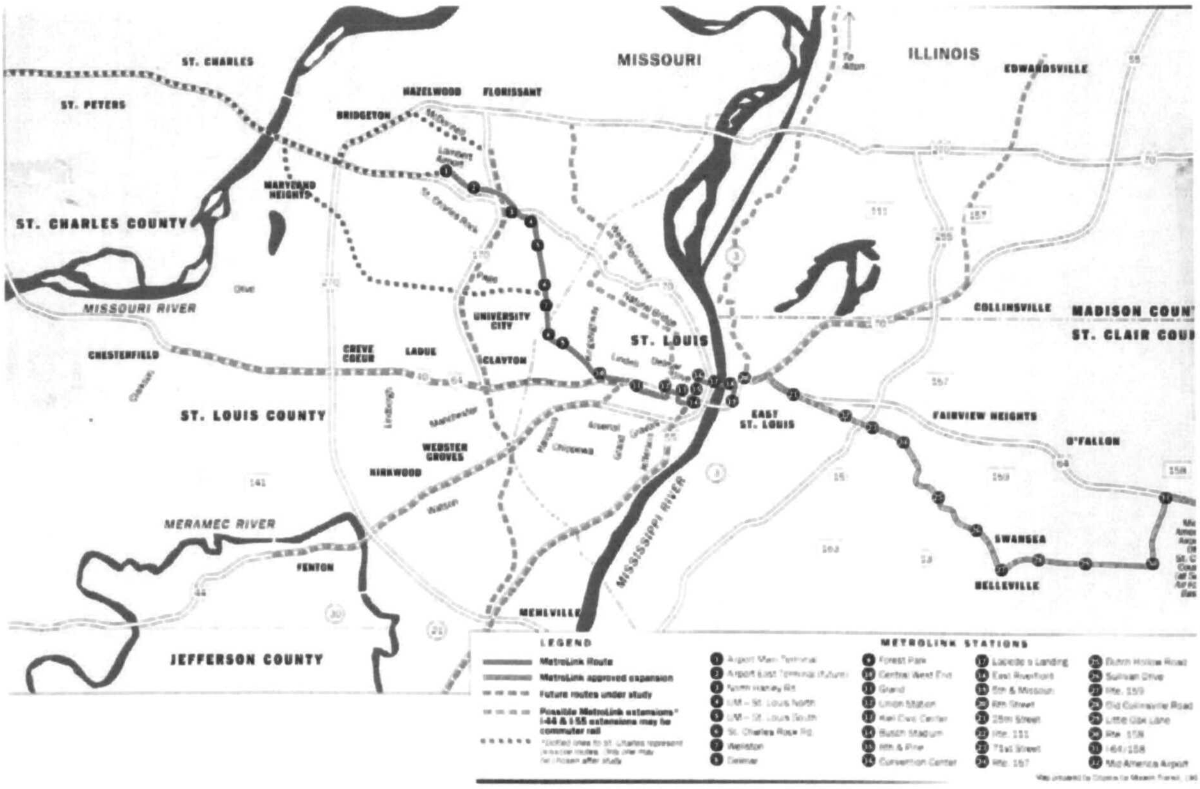
4.3.1.2 St Louis MetroLink

The planning of the urban rail system in St Louis was initiated as a response to various urban problems, such as air pollution, traffic congestion, population loss from the central city to the outer area, and rapid dispersal of the city. In addition, a non-governmental, citizens organisation, named Citizens for Modern Transit (CMT), played an important role in the development of the MetroLink by carrying out an intense campaign between 1985 and 1990 for the construction of an urban rail system. As a result, a light rail system was put onto the agenda in the metropolitan plans of the East-West Gateway Co-ordinating Council. The system was planned and built by the Bi-State Development Agency, in co-ordination with the East-West Gateway Co-ordinating Council.

The main objectives of developing the MetroLink was to improve public transport services, to reduce traffic congestion and to improve the air quality. In addition to these, to direct urban development was an equally important objective. MetroLink aimed to control the urban sprawl of the city, to reinforce the city centre, and to stabilise the economic decline of some areas along its north-western corridor (Stauder, 1997).

MetroLink opened for service in 1992 (Figure 4.2). Several extensions have been planned since then, one of which is currently under construction.

Figure 4.2 St. Louis MetroLink system map



Source: Map provided by the Bi-State Development Agency, St Louis.

4.3.1.3 San Diego Trolley

The light rail project in San Diego was initiated in the early 1970s, by the regional development plan of SANDAG, which emphasised the need of an urban rail service in the metropolitan area. Although traffic problems were not very severe at the time, SANDAG felt the need to address this issue for the near future. In addition, air quality problems and the decline of the city centre were important urban problems of the time, which led to the consideration of an urban rail system (Larwin, 1997b). Parallel to these plans, the City of San Diego, the municipality which covers the city centre, was also working on a city centre tram system in the 1970s. The City was planning a comprehensive redevelopment project for the city centre, and in its plans, it had designated the corridors where tram routes would be located (Stepner, 1997).

In 1975, the Metropolitan Transit Development Board (MTDB) was created by state law, with specific charge to plan and implement a fixed guideway system (Walmsley and Perrett, 1992). MTDB considered the regional problems addressed by the transport plan of SANDAG, but put more emphasis on transport problems of some urban corridors where there was lack of public transport alternatives. As for the city centre segments of the Trolley, the plan of the City of San Diego was used. To integrate the Trolley into the city centre redevelopment plan became an important criterion in planning the system.

The first section of the Trolley, the South Line, opened in July 1981. Since then several extensions opened, the last of which is the Mission Valley extension in late 1997. Figure 4.3 shows the system map.

The main objective of developing the Trolley was to provide good public transport service, considering the increasing car use and possible future problems with car traffic. Increasing public transport usage in the city, preventing traffic congestion, and improving air quality were primary objectives. In addition, contributing to the revitalisation of the city centre was an important objective. During the development of the first line of the Trolley, objectives targeted at urban growth management were not relevant since the first line was located in mostly developed urban areas. In the latter extensions, however, managing urban growth, increasing development densities, and creating developments in a transit-oriented way became significantly important (Larwin, 1997b).

Figure 4.3 San Diego Trolley system map

Source: Map provided by the Metropolitan Transit Development Board, San Diego.

4.3.1.4 Sacramento Light Rail

The light rail system of Sacramento had its roots in a city centre historic tramway proposal which was initiated in the early 1970s, by a citizen advocacy group of environmentalists and public transport supporters, called the Modern Transit Society (MTS). The project gained legitimacy in 1976, with the decision of the City Council to forego the construction of a 7.2 km of additional freeway in the north-east Sacramento and use the funds earmarked for the freeway as the basis for funding a 29.5 km light rail line. In this decision, strong citizen opposition to the construction of the freeway has been influential (Robinson, 1997). The light rail system opened in 1987 (Figure 4.4).

The system was built to address the air quality problems in the city and future car traffic problems that were anticipated to reach serious levels. Therefore, improving public transport services in the city, increasing public transport usage, preventing car traffic, and improving air quality were the primary objectives. In addition, improving and redeveloping urban areas along the routes were important objectives. It was also anticipated that the system would help increase the development densities, promote transit-oriented development, and help prevent urban dispersal.

4.3.1.5 Vancouver SkyTrain

Vancouver SkyTrain has its roots in the regional growth plan, The Livable Region, of the mid-1970s, which was produced by the Greater Vancouver Regional District (GVRD, 1976). According to the plan, metropolitan growth was directed along several radial corridors, along which sub-centres and new residential neighbourhoods would be created. This policy included the decentralisation of commerce and retailing from the CBD to the town centres of six municipalities, Burnaby, Westminster, Surrey, Richmond, Coquitlam and Londsale Quay. It was planned that employment centres and shopping facilities would be created in the sub-centres, and high density residential areas would be developed around these activities. While it was planned to decentralise commerce and retail activities from the CBD, residential and leisure development were encouraged there to create mixed land-use in central Vancouver (GVRD, 1976).

The GVRD proposed a light rail line that would connect the proposed sub-centres with the city centre. However, the circumstances under which the system was developed changed in 1980, when it was announced that a World Fair with a transportation theme was going to be held in Vancouver in 1986 (Parkinson, 1997). The Canadian Government and the Provincial Government planned to build a rapid transit system for the World Fair to demonstrate Canadian technology to the world. It was decided to be build an automated system, which was the type of technology used for the urban rail system in Toronto. This project was combined with the already existing light rail project of the GVRD. It was decided that all plans of alignment and stations would be kept as planned by the GVRD, but that a fully automated system would be built instead of a conventional light rail system (Parkinson, 1997).

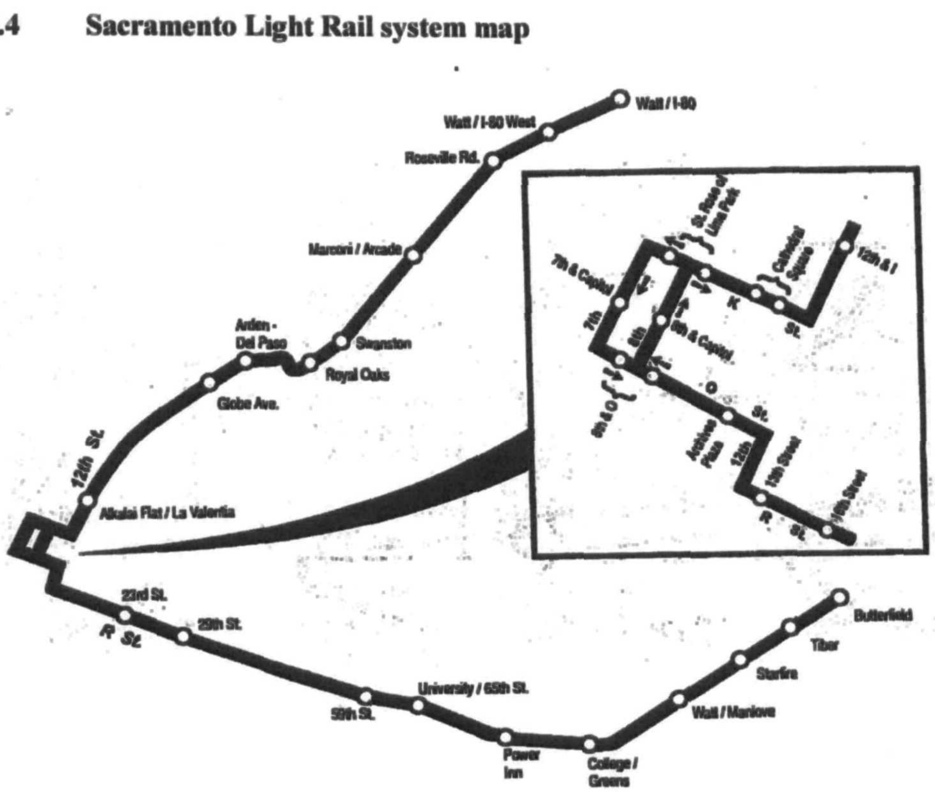
However, the GVRD was opposed to the automated system. Conflict between the governments, which was based on other political issues as well the SkyTrain project, resulted in the Provincial Government taking planning powers from the GVRD in 1983 (Magnusson, 1990b). BC Transit, as an agency under the Provincial Government, was created and took over the construction of the system.

The first phase of the system opened in 1986. The second phase was the extension towards Surrey, over the Fraser River; it opened in 1990. The third extension, which added three more stations to the system and extended it to the City of Surrey, opened in 1994. Figure 4.5 shows the system map.

The main objective of SkyTrain was to direct urban growth since it was designed as part of the regional growth strategy (Ward, 1997). Helping to create decentralisation through new town centres was the primary goal of SkyTrain. In addition, the revitalisation of declining areas along the SkyTrain route, which were supposed to become the new town centres, was an important objective.

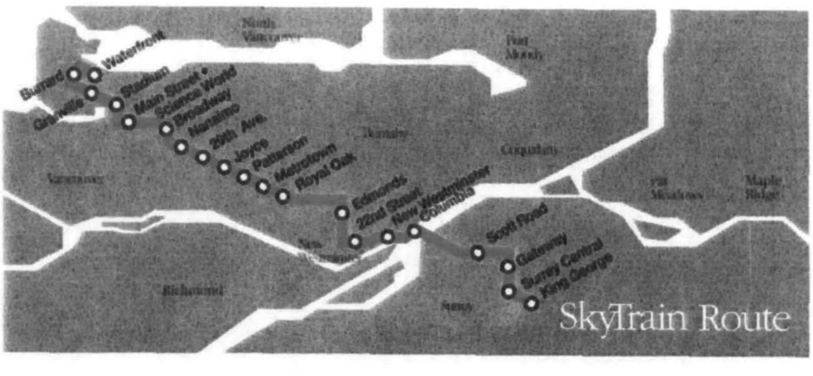
There were also transport objectives, such as increasing public transport usage, and reducing car traffic; however, they were not the prior objectives. Public transport use in Vancouver was always considered to be substantially high by North American standards. SkyTrain was a way of sustaining this relatively high level of transit patronage. For traffic congestion too, SkyTrain was seen as a preventive measure (Ward, 1997).

Figure 4.4 Sacramento Light Rail system map



Source: Adapted from TRB (1996b, p.39).

Figure 4.5 Vancouver SkyTrain system map



Source: BC Transit (1996).

4.3.1.6 Tyne and Wear Metro

The Tyne and Wear Metro was based on the Tyneside/Wearside Land Use Transportation Study of 1968 (Tyne and Wear Passenger Transport Executive, 1985). The rapid transit project emerged from the Tyne and Wear Plan which was produced in 1971 (Ridley, 1983) and proposed a fully integrated public transport system for the first time in Britain (Heseltine and Mulley, 1993). The plan also addressed a local problem that became important in the 1970s: the need and obligation to improve existing British Rail lines (Skelsey, 2000). The 1968 Transport Act gave the responsibility of subsidy payment for British Rail's local passenger services to the local areas. The passengers carried by British Rail in Tyne and Wear represented a 3% of the daily public transport passengers (Tyne and Wear Passenger Transport Executive, 1985). The British Rail service was either to be abandoned or improved. The second option was chosen, and the project was carried out as the North Tyne Loop Study. It was combined with the rapid transit plan: the tracks of the British Rail service became the system's route (Figure 4.6).

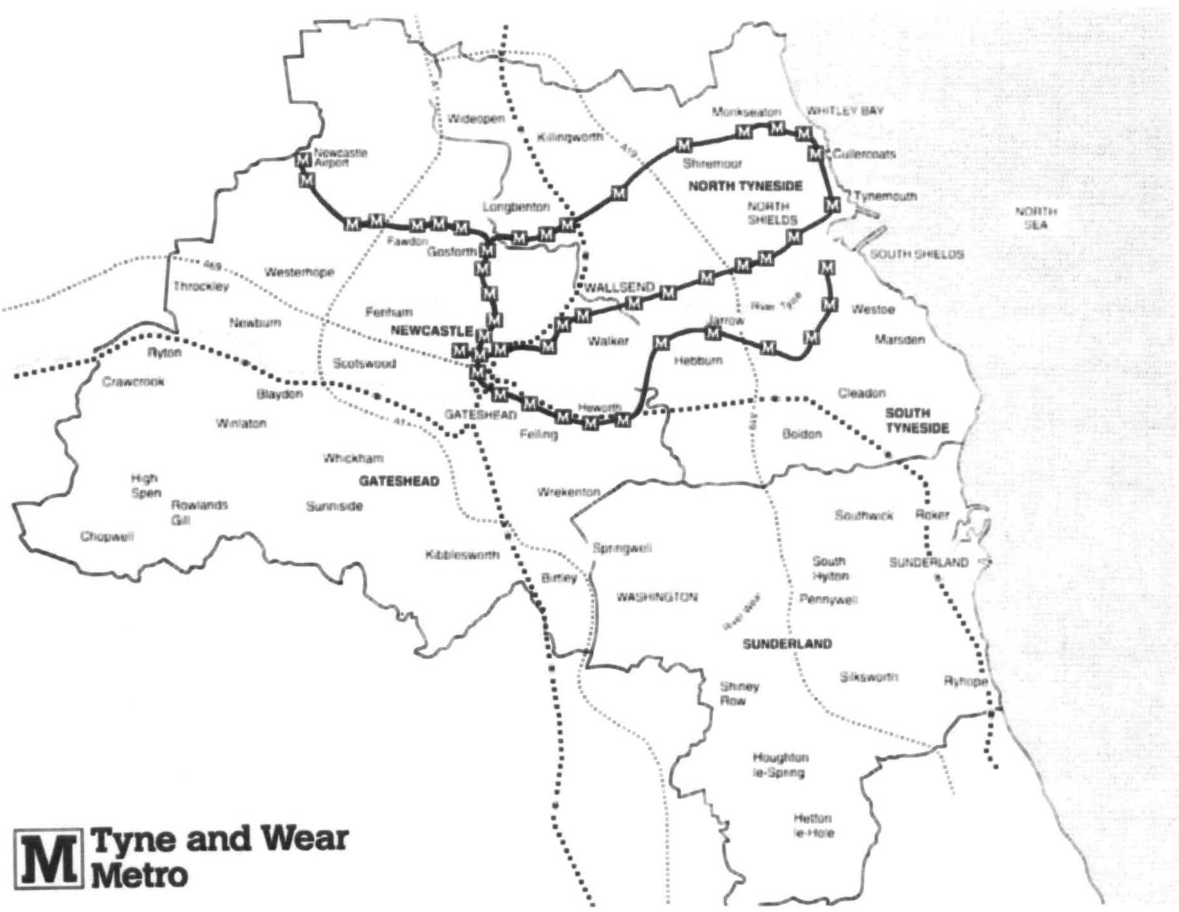
In the background of the planning of the rail system, employment policies and accessibility to employment were major aspects, as well as the concerns of the city planners in Newcastle and Gateshead about their city centre redevelopment projects. Improving the accessibility to the employment centres and to pedestrianised shopping areas in the city centre were important initiators of the project. In addition, with the North Tyne Loop Study, the improvement of public transport services became a major objective.

As a result, improving public transport services and increasing its usage in Tyne and Wear were the primary objectives of the Metro (Scott, 1998). In addition, revitalising declining industrial areas in the county, and supporting the urban renewal plans of Newcastle and Gateshead city centres were important objectives.

4.3.1.7 Manchester Metrolink

The rail network in Manchester had been suffering from the poor accessibility to the central business district and the lack of north-south cross-city rail links for more than a century. Studies and proposals to build a rail link between the two main rail stations,

Figure 4.6 Tyne and Wear Metro system map



Source: Howard (1993).

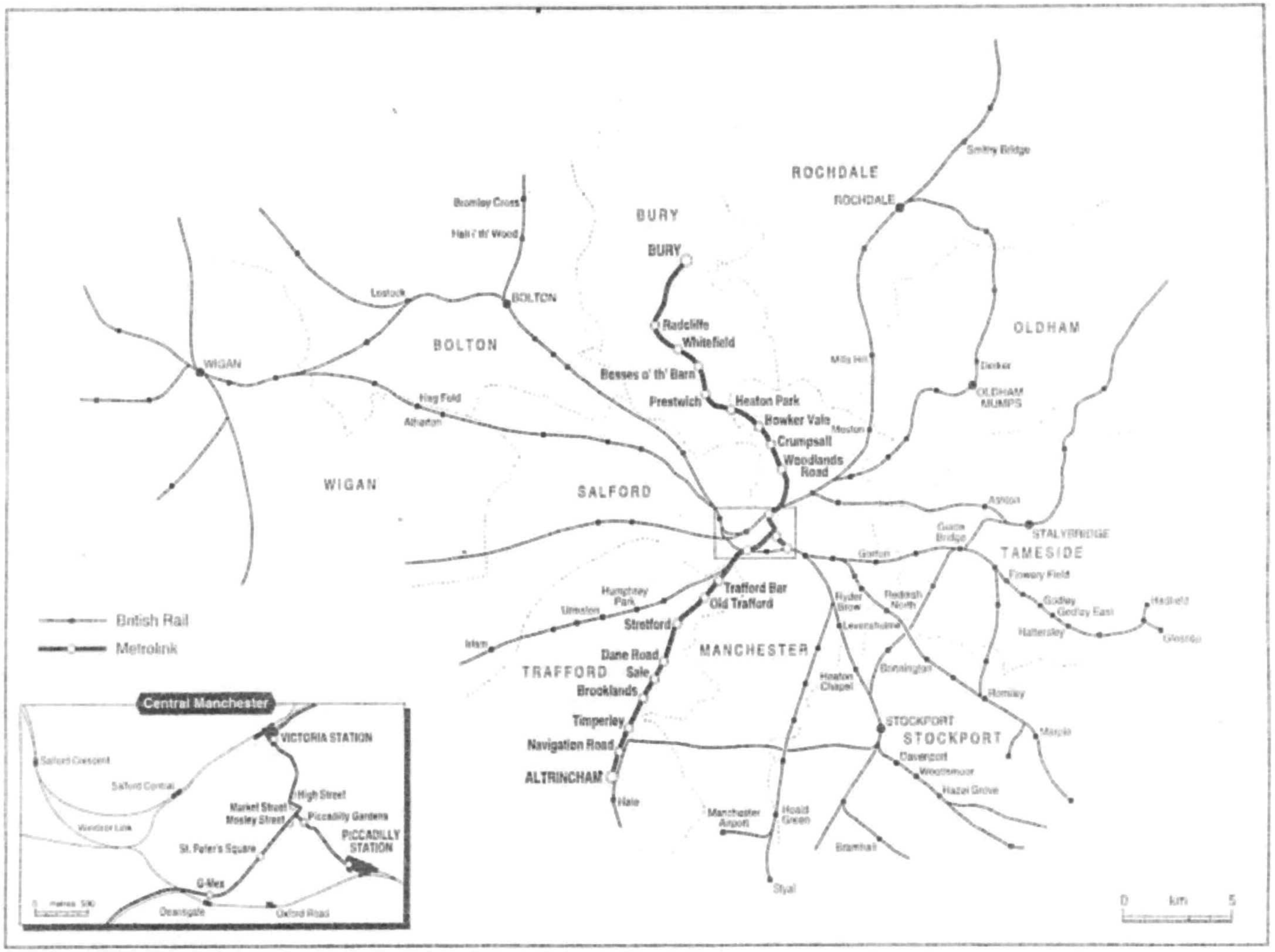
Piccadilly and Victoria, dated back to as early as the 1830s (Young, 1989). In 1965, the SELNEC Transportation Study was started. The focus of the study was on linking the Piccadilly Station to the Victoria Station by a rail tunnel under the city centre, a proposal known as the Picc-Vic Tunnel. However, funding could not be secured because of the high capital cost that tunnelling required (Ling, 1994).

The lack of city centre penetration remained a significant problem. In 1982 a Joint Rail Study Group was set up, comprising British Rail, the Greater Manchester County Council and The Greater Manchester PTE, and consultant Mot, Hay and Anderson, and produced a study which became the basis of the Metrolink. Its main objective was to find a solution to the rail network problems, bearing in mind the shortage of capital and the annual operating subsidy that had to be paid to British Rail. The outcome was the Metrolink using two former British Rail lines, and designed to run on streets in the city centre (Figure 4.7). The system opened for service in 1992.

Following from the main objective of the Rail Study Group, Metrolink was a scheme mainly to improve the rail network of the city. Therefore, the main objective of the scheme was to improve public transport services in the most efficient way and increase public transport usage. Out of 350 million public transport journeys annually made, only 25 million were made on rail (Young, 1989), mainly because of the inadequacies of the rail network in serving the city centre. Buses were not seen to be the most efficient way of providing a public transport service.

With an improved public transport service, it was also anticipated that reduction in traffic congestion would be achieved. Attracting car users was a key objective in developing the system. Land-use objectives were equally important in justifying the development of the scheme. It should be noted that the system was planned prior to the abolition of the metropolitan county councils; therefore, the system was planned by the Greater Manchester Metropolitan County Council. In the Council's plans, there was significant concern about the decentralisation of activities and dispersal of cities. A light rail system was seen as a way of reinforcing the city centre, attracting activities to the city centre, or in the case of areas outside the city centre, helping locate activities at the station sites, so that decentralisation would be managed in a transit-oriented way.

Figure 4.7 Manchester Metrolink system map



Source: Knowles (1996, p.4).

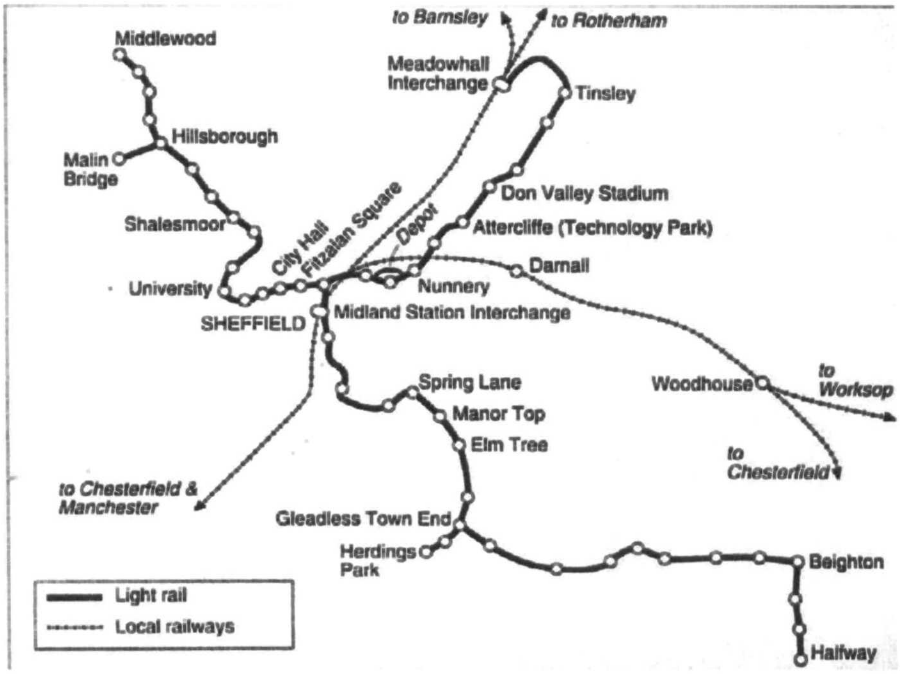
4.3.1.8 Sheffield Supertram

Sheffield Supertram has its roots in the 1976 Sheffield/Rotherham Land-Use Transportation Study, which recommended the safeguarding of alignments on six radial corridors to allow eventual construction of a segregated public transport system (Hague, 1994). The main objective of the study was to increase the efficiency of public transport services. Bus use was very high in the area, and the replacement of some of the bus services with an urban rail service was an operational objective. An urban rail system that would carry higher numbers of passengers per car was to be developed at the main bus routes instead of increasing number of buses carrying limited numbers of passengers.

During the 1980s, South Yorkshire Passenger Transport Executive (SYPTE) started to study the alternatives for the corridors, decided that a light rail line should be designed and constructed, chose one of the lines as the first phase, and started the process by submitting a Bill for Line 1 to the Parliament. However, in 1985, when the metropolitan county councils were abolished, the owner of the plan and the project was abolished; therefore, it was necessary to seek the support of Sheffield City Council. The city had doubts about the viability of the scheme after the 1985 Transport Act, which had brought about the deregulation of the bus industry (Hague, 1994; Hill, 1995). In 1987, a consultancy study revealed the scheme to be financially viable, and the Parliamentary procedures re-started. The Sheffield City Council gave its support to the project on some certain conditions which changed the route phasing, as will be discussed in the next sections. Sheffield Supertram opened in 1994. Figure 4.8 presents the map of the system.

When the need for an urban rail system was being discussed in the 1970s in the Sheffield/Rotherham Study, the main objective was to provide better public transport service in a cost-effective way. In later years, during the planning of the system in the second half of the 1980s, helping reduce the growth in car usage, relieving car congestion, and revitalising declining areas became other important objectives that justified the construction of the system (Kevill, 1998). These latter objectives had to be included in the scheme because of the Section 56 Grant application procedures. Section 56 Grant was made available if the scheme could reduce traffic congestion and regenerate declining areas by creating jobs or helping create jobs.

Figure 4.8 Sheffield Supertram system map



Source: Bushell (1997, p.341).

4.3.1.9 Summary of the objectives of the eight systems

The objectives for developing the systems are summarised in Table 4.7. It is seen that for all systems, increasing public transport usage was an important objective. To reduce growth in car usage, to relieve or prevent car traffic, and to stimulate development in declining areas were important objectives for most of the systems while to improve the pattern of urban development was important particularly for the North American systems. Stimulating development in the city centre was important for the systems in San Diego, St Louis, Manchester, and Tyne and Wear.

Table 4.7 Objectives for developing the eight urban rail systems

Systems in:	To increase public transport usage	To operate cost-effectively	To reduce growth in car use	To relieve car traffic	To improve air quality	To stimulate development in the city centre	To stimulate development in declining areas	To improve the pattern of urban development
Miami	•	•	•	•	•		•	•
St Louis	•		•	•		•	•	•
San Diego	•	•	•	•		•		•
Sacramento	•		•	•	•		•	•
Vancouver	•			•			•	•
Newcastle	•					•	•	
Manchester	•	•	•	•		•		•
Sheffield	•	•	•	•			•	

Source: Interviews with planners.

4.3.2 Public relations

All urban rail systems observed here went through a planning process that informed the public about the investment, and received public opinion as an input. In most of the case studies, public relations were successfully handled. In a few cases, there were problems in public relations, or negative reactions from the citizens. In this section, only these cases will be presented.

Miami is the only example where there have been extreme reactions from some citizens to the proposed system. Although there was an intense participation process with various communities for the planning of the metro, the alignment of the system raised severe public oppositions in some areas (Batista, 1997). The Overtown area was one of them. The area is adjacent to the city centre at north; it is one of the oldest neighbourhoods of Miami. It was the centre for black social and cultural activities for a long time, but have been decaying for the last decades. Before the construction of the Metrorail, an interstate highway was built passing through the Overtown and separating the neighbourhood into two. Residents who were affected by the highway fought against it; however, the highway was built. After the highway, the construction of the Metrorail had a similar effect on the Overtown area. It was constructed parallel, but not adjacent to the highway, therefore leaving residential areas in-between the highway and the rail, and dividing the neighbourhood furthermore (Figure 4.9). As a result, Metrorail received negative reaction from the residents of the Overtown, including vandalism on the trains and at station sites.

In Vancouver, in the first years of operation, SkyTrain received negative reactions from residential areas concerning the level of noise it produced. The problem was solved by building noise barriers along the system (Ward, 1997).

In Manchester, during the construction of the system in the city centre, many traders were affected by the road closures and long construction work, and these caused local opposition to the scheme to some extent. In Sheffield too, the construction caused disruptions for city centre traders. Although the disruptions were not directly because of the Supertram but because of utility infrastructure works that were done at the same time, Supertram was held responsible for retail closures (Kevill, 1998). However, these problems did not continue after the opening of the systems.

4.3.3 Route location

The routes selected for the development of urban rail systems can affect the success of systems since the characteristics of areas served by systems are important determinants of patronage. The location of routes of the eight systems are described in the following sections.

Figure 4.9 Overtown area in Miami: Metrorail constructed parallel to the highway

4.3.3.1 Miami Metrorail

One of the most important factors for the location of Miami Metrorail was the existing right-of-railway which belonged to an abandoned rail service. The right-of-way paralleled one of the most congested corridors in Miami (highway US-1); therefore, TSD considered it to be an efficient corridor to provide high capacity transit service. For the other parts of the route, that is the northern sections, it was decided that a high capacity and high quality transit service was necessary in these areas in order to improve the access for low income households and to help revitalise the area. It was also important to convince the Federal Government that the investment would provide better transport services for low income households, and help revitalise economically depressed areas (Garcia, 1997).

The system serves mostly residential and retail areas. The northern parts of the line serve economically depressed neighbourhoods. The southern parts serve a more affluent area, dominated by retail developments.

4.3.3.2 St Louis MetroLink

In St Louis, the location of the light rail was determined by two main factors: affordability and penetration of declining areas. In order to build the line in the most affordable way, existing tracks were followed wherever possible. There was an abandoned rail track passing from the city centre towards the north-western settlements, some parts of which are declining slum areas. The availability of the existing track and the opportunity of revitalising these areas made this route appropriate for the alignment of the system (Stauder, 1997).

The MetroLink does not serve areas that the main development trends are in favour of. The areas where the system runs through are those that the planners try to reinforce and revitalise. MetroLink is supposed to stabilise these areas, prevent their loosing population, and help revitalise them. During the planning of the system, it was anticipated that providing urban rail access from the CBD to new and affluent development areas, and particularly to the Clayton Office Centre, which is a new commercial centre, would cause further decline of the CBD by enabling city centre residents and employers to access these areas more easily.

Although the MetroLink does not serve areas of new development, its route penetrates several activity centres in the city. This is probably because the corridor is an old radial corridor, along which the city had grown. There are several urban activity centres, such as medical centres, leisure and retail centres, commercial areas, and sports stadiums, which are likely to attract and generate trips on the MetroLink. These activity centres are predominantly at the city centre. In other parts of its route, the MetroLink serves a university campus area, a recreational park, the airport of the city, some declining industrial areas as mentioned, and residential areas of a combination of different income levels.

4.3.3.3 San Diego Trolley

For the overall planning of the San Diego Trolley, a low cost investment strategy was important since the initial line was built by local resources. Therefore, one of the important objectives was to keep the cost down for the route selection. Until the latest extension of the Trolley, which is to the Mission Valley, the lines were built on existing right of ways and on tracks of abandoned railroads. However, in addition to the availability of existing tracks, there were other considerations. The South Line (the southern part of the line which is now called the North-South Line), which was given priority in investment, was selected because the corridor had the highest potential of generating public transport trips in the city. Public transport usage along the corridor was already at substantial levels. Both ends of the line, the city centre at one end and the Mexican border at the other, were important trip attractors and generators. The rest of the line, on the other hand, is occupied by small scale industries and residential areas, some of which are low-income. The extensions of the South Line towards north serve some residential areas and areas of tourist attractions.

East Line serves a different type of urban area, mainly suburban with higher income residents. The route was selected because it was compatible with urban plans, which proposed urban development towards the eastern settlements. The Mission Valley Line, which opened in late 1997, is not included in the analysis.

4.3.3.4 Sacramento LRT

In locating the Light Rail of Sacramento, the main determinant was the availability of right-of-way. The Northern Line runs parallel to a highway for most of its route. It also serves small scale industries, some of which are in poor economic condition. The Eastern line (Folsom Line) uses existing track on which a freight line is operating. The corridor serves residential suburban areas occupied by high-income residents.

The lines are not compatible with the natural direction of urban growth. Apart from the CBD, there are few activity centres which may attract or generate trips along the line.

4.3.3.5 Vancouver SkyTrain

The location of the SkyTrain was planned by the GVRD to be along one of the corridors that were proposed in the regional growth plan to be the main corridors of urban growth. Among other alternatives, the choice of that particular corridor for the SkyTrain was to a certain extent determined by the availability of a right-of-way. The location of the existing right-of-way was convenient because it enabled the planners to build a system that could connect the city centre of Vancouver with three of the new town centres proposed in the regional plan.

The existing rail track was originally built for passenger rail services, but it had been used for freight since the 1950s. As a result, there is a history of residential development in the corridor; however, an important part of the route passes through old industrial areas, some abandoned, some still in use.

4.3.3.6 Tyne and Wear Metro

It will be remembered that an important justification for the urban rail investment in Tyne and Wear was the need to modernise and improve the existing passenger tracks. The location of lines was determined by the location of the existing passenger tracks. These tracks were located conveniently since the previous passenger service was serving most of the main employment and residential areas of the county. The lines serve a combination of different income areas.

For the city centre part of the Metro, underground access was chosen because the technology of the system was not appropriate for non-segregated street-running design. Besides, planners in the City Councils of Newcastle and Gateshead believed that underground access would be more compatible with their city centre redevelopment schemes since it would allow pedestrianisation of some city centre streets and squares (Martin, 1995).

4.3.3.7 Manchester Metrolink

For the Manchester Metrolink, six lines were proposed, and among them, the Bury and Altrincham lines were selected for the first phase of the scheme. The Bury line was the prime candidate for light rail because it had been originally electrified in response to tram competition, and was operating in isolation from other railways in the area: it had its own depot, trains and staff (Holt, 1992). Furthermore, the line was very old and needed to be upgraded. As for the Altrincham line, it was originally the fifth line considered by the study group; however, it became another prime candidate with its already existing electrification, and its strong LRT characteristics due to its visible penetration of residential areas and closely spaced stations (Holt, 1992). Another factor was that the main problem of the rail network was a missing north-south link through the city centre, which is now provided by the Bury-Altrincham Metrolink line.

Because both of the lines were located at former passenger rail lines, they serve well developed, medium income residential areas, where there is already a substantial level of public transport patronage. On the other hand, there are also some small scale industrial areas, most of which are in economic decline.

4.3.3.8 Sheffield Supertram

Five corridors were chosen in the Sheffield/Rotherham Study, two of which have been selected by the Metropolitan County Council to form the first line of the Supertram. The line extended from Hillsborough to Mosborough. The existing development trends did not favour these areas; however, Mosborough, which is at the south-eastern part of the city, had long been the area towards where the county and city councils were trying to direct urban growth. The line mostly serves low income neighbourhoods. During the planning stages, there were several high density council houses along the route, which were a valuable potential for public transport patronage. However, these houses were demolished by the City Council during the construction of the system (Fox, 1996; Kevill, 1998).

The second line was designed to be along the Lower Don Valley, which was a declining industrial area. Sheffield City Council was planning for the regeneration of the area, and had given permission for the development of a big shopping centre at the end of the route, Meadowhall Shopping centre, which it was anticipated would generate trips on the tram. It was mentioned earlier that when the County Council was abolished, Sheffield City Council's support was necessary to proceed with the tram project. The City Council gave its approval to the scheme on the condition that the Lower Don Valley line was built first, not only for regeneration concerns, but also to support its investment in a large sports stadium at the Lower Don Valley for the World Student Games that Sheffield was hosting. As a result, the Don Valley Line was the first line to be built. The Hillsborough-Mosborough Line opened as the second line.

None of the lines serve areas where there are favourable conditions for development. The Don Valley line, in particular, is a declining old industrial site. The area contained a regeneration project by the Sheffield Development Corporation (SDC) during the development of the tram; however, the line is not located conveniently enough to penetrate the activities and developments of the SDC. Both the City Council and the SYPTE preferred to locate the system on an existing rail track in order to build the line in the cheapest and quickest way (Haywood, 1998c; Keyworth, 1998). However, the existing track is not very accessible to new development areas. (See the figure on page 118.)

4.3.4 Design features of the systems

The design features of the systems, such as the technology, scale, grade separation, level of segregation, and stop frequency are listed in Table 4.8. Among the eight systems, only Miami Metrorail is a full metro. Vancouver SkyTrain and Tyne and Wear Metro are categorised in some documents as heavy rail, and in some others as light rail; in this study, they are categorised as light rapid systems. They use light rail vehicles on fully segregated rights-of-way and have a third rail power supply. Vancouver SkyTrain and the city centre part of the system in Miami, the Metromover, are automatic systems: they are operated without drivers. The systems in St Louis, San Diego, Sacramento, Manchester, and Sheffield are light rail systems.

Table 4.8 Design features

Systems in:	Technology	Capacity (passengers/ hour/direction)	System length (km)	Number of routes	Grade separation	Segregation from other traffic	Number of stops	Average stop spacing (km)
Miami	metro	11,808	33.8	1	separated	complete	21	1.61
St Louis	light rail	3,026	27.2	1	both	complete	18	1.51
San Diego	light rail	3,600	80.4	3	at grade	partial	48	1.68
Sacramento	light rail	2,240	29.2	2	at grade	partial	29	1.01
Vancouver	light rapid	9,600	28.9	1	separated	complete	20	1.45
Newcastle	light rapid	4,432	59.1	3	both	complete	46	1.28
Manchester	light rail	4,120	31.0	2	at grade	partial	26	1.19
Sheffield	light rail	2,430	29.0	2	at grade	partial	45	0.63

Source: Data provided by experts through interviews or documents.
Note: Lengths of the systems in the year 1998 are taken as the basis since performance analysis will be based on 1998 data. Capacity is calculated by multiplying the number of trains per hour with the maximum number of cars in a train and the passenger capacity per car.

Miami Metrorail, being a full metro, has the highest capacity for carrying passengers. Vancouver SkyTrain also has a high capacity, which is a consequence of its automatic technology that enables very high frequency of service. Tyne and Wear Metro has a capacity similar to the light rail systems. Originally it was planned to run four-car trains, and its city centre stations were designed accordingly. However, during the construction of extensions, stations were designed to accommodate only two-car trains in order to reduce the cost of construction. As a result, the capacity of the system was reduced. The rest of the systems, light rail systems, have comparable capacities, with Sacramento LRT and Sheffield Supertram having the lowest capacity.

San Diego Trolley and Tyne and Wear Metro are the most extensive systems: both have three routes. All other systems have one or two routes and are smaller in scale.

Miami Metrorail and Vancouver SkyTrain are grade separated systems. Both of them are elevated; Vancouver also has an underground section in the city centre. St Louis

MetroLink and Tyne and Wear Metro are mostly at grade; only the city centre segments of these systems are underground, and therefore grade separated. The systems in San Diego, Sacramento, Manchester, and Sheffield run at grade. These four systems are also the only ones which have street-running segments; others are completely segregated from traffic.

The systems in Sheffield and Sacramento have the lowest values for stop spacing. It can also be observed that the British systems tend to have lower average spacing between their stops than their North American counterparts.

4.4 OPERATION OF THE SYSTEMS

The way the systems are operated is illustrated in Table 4.9. The most frequent system is Vancouver SkyTrain, which operates at 2.5 minute intervals at peak times of the day. This high frequency is enabled by the automatic technology of the system. Manchester Metrolink follows the SkyTrain with its fairly high frequency. It is also important to note that the frequency of the system, particularly at off-peak times of the day, is much higher than that of the previous rail service that the system replaced (Knowles, 1996). The systems in Sheffield, St Louis, and Tyne and Wear also provide fairly frequent services. Sacramento LRT, on the other hand, operates at a remarkably high headway: trains in Sacramento run every 15 minutes all day.

Table 4.9 Operating characteristics

Systems in:	Headway (minutes)	Service hours per day	Mean speed (km/hr)	Fare structure	Number of fare zones	Travelcard	Ticket enforcement method
Miami	7.5 / 15	18.30	49.9	flat	1	yes	barriers
St Louis	7 / 10-15	19.00	56.3	flat + free zone	1	yes	random
San Diego	10 / 15-30	20.36	46.6	zonal	4	yes	random
Sacramento	15	19.39	46	flat + CBD	2	yes	random
Vancouver	2.5 / 5	20.07	45.5	zonal	3	yes	random
Newcastle	7.5 /10-15	18.5	30	zonal	5	no	random
Manchester	6 / 12	18	36.2	zonal	7	no	random
Sheffield	6 / 15	18	26	zonal	4	yes	sale on board

Source: Data provided by experts through interviews or documents.

Daily hours of service are similar across the systems. North American systems seem to run slightly longer than the British ones; however, the difference is not significant.

One remarkable point is that British systems have lower mean speeds; this is particularly significant for the Supertram in Sheffield. This may be because of low spacing between stops.

In Miami and St Louis, the fare structure is flat, that is only one fare is used throughout the lines. In St Louis, however, there is also a free fare zone, where free journeys are offered among six city centre stations at off-peak times of the day. In Sacramento, too, the fare structure is effectively flat although there is a different fare for the city centre, which is cheaper than the regular fare. The other five systems have zonal fare systems. In San Diego and Sheffield, there are four different zones; in Vancouver, there are three zones; in Tyne and Wear, there are five zones; and in Manchester, there are seven zones.

In North American systems, travelcards which provide unlimited journeys on both the urban rail systems and buses have been introduced; daily, weekly, monthly, and annual cards are available. In Britain, because of the deregulated nature of the bus industry, it is difficult to introduce travelcards. In Newcastle and Manchester, there are current studies about introducing them. In Sheffield, there is a daily travelcard, and a one-hour card which provides unlimited journeys on buses and the tram.

Among the eight systems, only Miami Metrorail has barriers at the entrance of the system; hence, ticket inspection is through machines at the entrance of the platforms. All other systems have barrier-free entrances, and ticket enforcement is provided through random ticket inspections. On Sheffield Supertram, ticket inspection has not been necessary since the introduction, in 1998, of ticket sales on board by an additional member of staff.

Fare levels may also be influential on the performance of the systems. These are listed in Table 4.10. St Louis Metrolink has the lowest fares, followed by Sacramento LRT and Miami Metrorail. Manchester Metrolink, on the other hand, has remarkably high fares. This is worth noticing because it is one of the two systems that are privately operated.

Sheffield Supertram has recently been sold to the StageCoach company: it has been privately operated since December 1997. However, its fares are not as high as those on Manchester Metrolink.

In the North American cities where fares are integrated with buses, a single journey costs the same on both systems. Only in Miami, in the early years of operation, Metro journeys cost more than bus journeys.

Table 4.10 Ticket fares

	Full fare (£)	Concessionary fare (£)	Transfer fare between the urban rail systems and buses (£)
Miami Metrorail	0.81	0.39	0.16
St Louis MetroLink	0.65	0.32	0.06
San Diego Trolley	0.65 - 1.13	0.49	free (within the same zone)
Sacramento LRT	0.16 - 0.81	0.32	free (within the same zone)
Vancouver SkyTrain	0.71 - 1.43	0.36 - 0.71	free (within the same zone)
Tyne and Wear Metro	0.50 - 1.60	0.25 - 0.30	N/A.
Manchester Metrolink	1.20 - 2.90	0.32	N/A.
Sheffield Supertram	0.50 - 1.20	0.33	N/A.

Note: US Dollars and Canadian Dollars are converted to English Sterling using Purchasing Power Parities index provided by the OECD (1999).
N/A: not applicable.

4.5 POLICIES IMPLEMENTED TO SUPPORT THE SYSTEMS

4.5.1 Miami

During the planning of Metrorail, it was planned to implement three supporting measures: buses would be improved and organised to feed into the system; service levels and frequency of the metro would be continuously improved; and car restriction measures would be introduced in the city centre. The first two could not be realised because of financial problems that followed reductions in the Federal Government Funds, and because the construction cost exceeding the budget. The last policy could not be realised either because of political debates on restricting car use in a car-dominated city like Miami, as well as the concerns that the city centre would be negatively affected by car restriction (Garcia, 1997).

There have been some urban planning policies to support the system. The TSD had an intense programme of joint development projects at station sites since it owns most of the land around stations (Talleda, 1997). Joint-development projects were realised by offering developers the air rights. In some cases, the developers were required to build parking areas, which were used as park-and-ride for the Metrorail. Joint development schemes were offered along the whole line; however, they were realised only along the Southern line. Developments include an office complex, retail complexes, a hotel, and high-rise residential apartments.

In addition to joint development projects, tax incentives were also used by the TSD to encourage development along the Metrorail. Developers were offered tax reductions when they located their development in close proximity to the rail line. Reductions in car parking requirements were also offered as an incentive for investors: if development was close to the transit line, the parking capacity that the developer was required to provide was reduced (Garcia, 1997). Another development-related activity in Miami was the Enterprise Zone that was announced in economically depressed areas. However, it was initiated by the Federal Government, and therefore was not integrated with the Metrorail.

4.5.2 St Louis

The main policy to support the light rail investment in St Louis was the integration of the system with buses. Almost all bus routes were reorganised. At the same time as the reorganisation of the routes, a major improvement in bus services was made. All routes were simplified and shortened. The underlying strategy was that when the bus routes are longer they are more likely to be out of schedule; when they are shorter, they will not only be more reliable, but also easier to understand, and therefore more user-friendly and more attractive (Stauder, 1997). In addition, on some routes, buses were especially painted for easy recognition.

Another action was introducing a free travel zone in the city centre. Between the six stations that cover the city centre of St Louis area, MetroLink journeys are free between 10 a.m. and 3 p.m. In addition to free travel offers, several marketing and advertising actions were taken, particularly by the voluntary citizen organisation, Citizens for Modern Transit.

Personal safety on board, at stations, and at car parks, was another important issue in St Louis because crime is a severe social problem in the city. The Bi-State Agency formed a social security department for the MetroLink operations, and employed substantial numbers of security staff on board, at stations, and at parking areas. At many station sites, outside the city centre, car parking areas were provided, to encourage car users park their cars and ride the MetroLink.

There have also been land-use and development-related actions. Most new government buildings and other developments built by public agencies were located at MetroLink stations, particularly at city centre stations. As for developments by the private sector, tax incentives were introduced to attract them to station sites. Tax reductions were offered if the developers chose to locate their development close to MetroLink stations (Farrell, 1997; Stauder, 1997).

During the planning of the MetroLink, it was planned that a redevelopment project for the city centre would be implemented together with the MetroLink; however, there has not been a comprehensive redevelopment and renewal programme introduced yet. Along the north-western parts of the MetroLink route, there is an urban rehabilitation programme, carried out by the East-West Gateway Co-ordinating Council and aimed at regenerating the economy of the area. During the planning of the MetroLink, the urban rehabilitation programme was among the factors that justified the location of the north-western route of the system. However, the MetroLink project proceeded faster than the rehabilitation project.

4.5.3 San Diego

In San Diego too, reorganising and integrating buses with the new system were among the main tools used to support the light rail investment. Providing car parking areas at station sites was again among the important policies to attract car users to the Trolley. Marketing and advertising were also used: free rides and guided tours were organised at new extensions.

In addition, incentives, such as reductions in tax and car parking requirement, have been used particularly in the central areas of the city to attract developers to the Trolley stations (Larwin, 1997). There were also reductions in a development fee which was charged to the developers according to the traffic their development was likely to generate: assuming that a development near public transport stops would generate less car traffic, the fee was reduced for such developments (Bragado, 1997). In addition, some joint development projects were implemented. The city centre street which the Trolley passes through was closed to traffic.

Integrating the Trolley project with the city centre redevelopment project was an important policy that was anticipated to be beneficial for the Trolley patronage. The city centre segments of the Trolley were planned in accordance with the redevelopment project. In return, the municipality was requested to locate some activities within the redevelopment project at proximity to the Trolley stops (Stepner, 1997).

4.5.4 Sacramento

In Sacramento too, reorganisation of buses and their integration with the LRT were planned as the primary policies to support the system. Because the LRT could not be built within the budget, reorganisation and integration of buses could not be realised until few years after the LRT opened (Robinson, 1997). In addition to bus integration, providing car parks at stations outside the city centre was an important policy to attract passengers, particularly car users. Also, free rides were offered to public when the system first opened for service.

Several urban planning policies have also been implemented. Tax incentives, reduction in development fees, development bonuses, and relaxation of the requirement for car park provision were offered to developers that chose to locate close to LRT stops (Burness, 1997). New public building were located at LRT stops. In addition, one of the city centre streets along which the LRT runs was pedestrianised and redesigned as an open-air shopping mall.

In Sacramento, there is an agency called the Capitol Area Development Authority (CADA) which develops medium density housing in central Sacramento to create mixed land-use in the city centre. CADA also puts significant emphasis on transit-oriented development and had influenced the city centre alignment of the light rail so that its project area could be better penetrated by the LRT (Plescia, 1997). Nevertheless, the location of the CADA houses and the LRT stops do not appear to be very well integrated.

4.5.5 Vancouver

In Vancouver, reorganising bus routes to feed the system, and providing security staff on board and at stations were among important actions taken to increase the patronage of SkyTrain.

Before the opening of the system, one section of the SkyTrain was opened to public for free, in order to demonstrate the new technology to the public and to prove that automatic operation was safe.

Vancouver SkyTrain is the only system observed here, which did not have a policy of encouraging park and ride as a means of attracting car users and increasing the patronage. Planners anticipated that parking areas would prevent development taking place at station sites (Parkinson, 1997).

The main planning action to support the SkyTrain investment was to encourage development along the system. Municipalities rezoned station areas for commercial, retail, and high density residential development, and implemented joint development projects at some station sites (Ito, 1997; Lion, 1997; Stott, 1997). Incentives, such as development bonuses, tax reductions, and a reduction in the parking requirement, were also used to attract developers along the system. In addition, many public buildings and utility headquarters were relocated at SkyTrain stations.

Developments that took place along the SkyTrain were enabled by urban renewal projects. An important amount of land along the SkyTrain corridor was occupied by old industrial areas, some abandoned and vacant, some declining. Municipalities were planning for the redevelopment of these areas before the SkyTrain was planned. When the SkyTrain plans were announced by the GVRD, municipalities adapted their plans to the SkyTrain, and redeveloped most of the areas for residential, with commercial and retail developments focused at stations, as proposed in the Regional Plan of the GVRD. It is notable that most of these planning actions took place during the construction of the SkyTrain when the GVRD had lost its planning power and the regional plan had lost its legitimacy. The municipalities remained exceptionally committed to the regional plan, and adapted their local plans to the regional plan and to the development of the SkyTrain corridor (Parkinson, 1997; Stott, 1997).

4.5.6 Newcastle upon Tyne

The primary planning measure taken to support the Metro investment in Tyne and Wear was the integration of the buses with the system, and bus and car traffic arrangements in the city centre. After 1986, with the deregulation of the buses, the integration could not be sustained. In addition, at several Metro stations, car parks are provided, to attract car users to the system.

There has also been a town planning action: some streets in the city centre have been pedestrianised as part of the city centre redevelopment project. Although this project was initiated before the Metro project, and therefore was not implemented merely to support the Metro, it was well co-ordinated with the location of Metro stations in the city centre.

In addition to supporting policies, there were policies in Newcastle upon Tyne that conflicted with the Metro. The Enterprise Zone (EZ), for example, resulted in the development of a large shopping centre, the Metro Centre, at an area outside the Newcastle city centre, which is not served by the Metro. In addition, the developments realised by the Tyne and Wear Development Corporation (TWDC) were not very supportive of the Metro either. In fact, the regeneration area had limited interaction with the Metro; however, as Byrne (1999) argues "the form of development achieved by the TWDC with a very high office/car-park content is quite contrary to long established county (but not Newcastle City) policies asserting the significance of public transport and the desirability of locating large office development adjacent to peripheral Metro stations" (p.135). The location of the Metro and the EZ and TWDC projects are illustrated in Figure 4.10.

Byrne's (1999) observation also implies that the policies of Newcastle City are not supportive of the Metro. Indeed, the interview with the planners in Newcastle City Council revealed that current proposals for residential and commercial development were in areas which are not served by the Metro.

4.5.7 Manchester

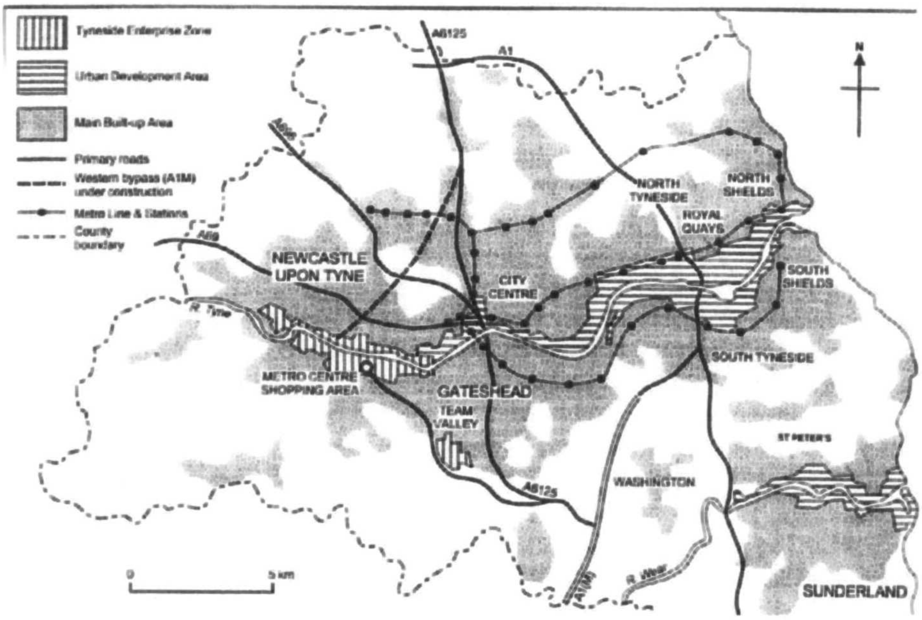
In Manchester, like most of the other systems, providing car parks at stations outside the city centre was among the measures which were introduced to increase the patronage of the system by attracting car users. There have been few actions regarding land use and development. One city centre street has been pedestrianised; several buildings and squares in the city centre have been renewed. However, these actions were not initiated by the Metrolink, but followed a bomb attack which destroyed parts of the city centre. In addition, there was intense investment in the southern parts of the CBD by the Central Manchester Development Corporation (Figure 4.11). The CMDC not only regenerated the office development market, but also initiated city centre housing (Deas et al, 1999).

4.5.8 Sheffield

The StageCoach, the operator of Supertram since December 1997, introduced various operational actions to enhance the success of the system. On-board ticket sales were introduced by employing additional staff on the trams. The policy addressed problems regarding the usage of ticket machines at tram stops: public found the machines difficult to use. In addition, the number of machines at tram stops was not enough: the problem caused queuing at stops, and chaos upon the arrival of trams. Ticket sale on board by an inspector was expected to solve the problem, as well as reduce fare evasion (Brown, 1998).

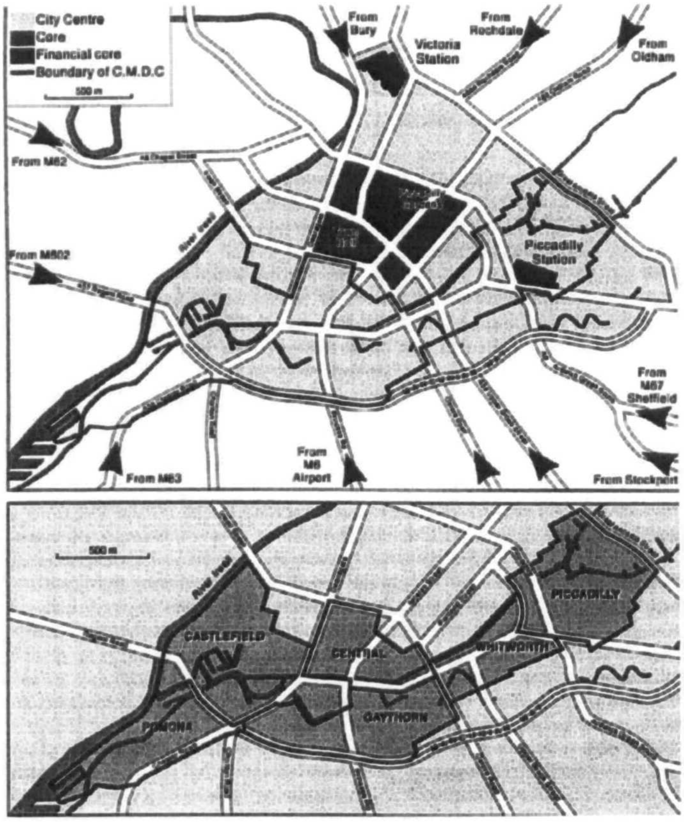
Another policy was to introduce one day and one-hour travelcards that are valid on both trams and buses. In addition, fares for weekend rides were reduced. Car parks were also provided at tram stops outside the city centre.

Figure 4.10 Tyne and Wear Development Corporation and Enterprise Zone area



Source: Byrne (1999, p.134).

Figure 4.11 Manchester Development Corporation area



Source: Deas et al (1999, p.208).

When the system first opened, free rides were offered to the public as a marketing policy. The interview with the planners revealed, however, that this policy caused chaos and overcrowding.

During the construction of the Supertram, there was a massive regeneration project along one line of the system. This project was led by the Sheffield Urban Development Corporation. However, the system is located at the margin of the regeneration area (Figure 4.12). Its location is inconvenient for accessing the new developments. Therefore, it is difficult to suggest that the regeneration project was a planning activity which supported the tram investment. In addition, it has been argued that the two projects were poorly integrated because of the lack of integration between the transport providers and the development agencies (Dabinett et al, 1999; Lawless, 1999).

There have been some planning actions in Sheffield that conflicted with the Supertram. As mentioned in Section 4.3.3.8, some high density residential council houses were demolished by the City Council during the construction of the tram although the alignment of the tram had been planned to serve these houses.

4.6 SUMMARY

In this chapter, various factors regarding the planning process and planning background of the eight case studies have been described. The factors included external factors, planning factors, operating policies, and supporting policies. The effect of these factors on the success of the systems are analysed in the next two chapters. In Chapter 5, success of the systems are analysed and possible links between their success and the factors introduced in this chapter are discussed. In Chapter 6, the effects of factors are analysed in more detail; links between the factors and success are established, and a planning framework is developed in the light of the findings.

Figure 4.12 Sheffield Development Corporation boundaries

Source: Dabinett and Ramsden (1999, p.170).

5. CASE STUDY ANALYSIS: MEASURING SUCCESS

5.1 INTRODUCTION

This chapter presents the analysis of the success of the eight case studies. The analysis is based on the methodology introduced in Chapter 3. Success is measured by the extent to which urban rail systems attain the five objectives that were identified in Section 3.2.2.1 of Chapter 3. The objectives are attaining high patronage, building and operating the system cost-effectively, increasing public transport usage, preventing or solving traffic congestion and environmental problems associated with it, and, finally, improving the land use and urban growth patterns, which cover three sub-objectives: stimulating development at the city centre, stimulating development in declining slum areas, and improving the pattern of urban growth by transforming it from a car-oriented to a public-transport-oriented pattern. The success of systems will be measured by their performance in attaining these objectives.

The performance of systems in attaining the objectives is measured by specific criteria. Three criteria are identified for each objective. The more criteria the systems fulfil, the more successful they are regarded as being in this work. The criteria are based on the indicators that were identified in Chapter 3, and listed in Table 3.1. The criteria are presented in Table 5.1. There was discussion in Chapter 3 about the issue that the choice of indicators may affect the outcomes of the success analysis. Therefore, throughout the analysis, other indicators of success will also be discussed in order to try to avoid any bias that may result from the choice of criteria.

During the analysis of the indicators that the criteria are based on, comparisons with the performance of other urban rail systems will be made when data is available. For example, the American light rail systems will be compared with other new light rail systems in the United States; Miami Metrorail, which is a metro, will be compared with other new metros in the United States; Vancouver SkyTrain will be compared with new light rail systems and metros in Canada since its technology is between light rail and heavy rail; and the British systems will be compared with new light rail systems in Europe which also include Docklands Light Rail in London. When data is not available for other urban rail systems, the performance of systems will be compared with average performance of the eight systems.

Table 5.1 Criteria analysed for measuring the success of systems in attaining their objectives

Objectives	Criteria for the attainment of objectives
Attaining high patronage	Patronage is not lower than the forecast Patronage per route kilometre is higher than the national/continental average Vehicle load is higher than the case study average
Building and operating the system cost-effectively	Capital cost per passenger is less than the national/continental average Operating cost per passenger is less than the case study average Farebox recovery ratio is higher than the case study average
Increasing public transport usage	Modal share of public transport increased after the new system Bus patronage did not decline due to the new system The patronage of the new urban rail system is increasing
Preventing/solving traffic congestion and environmental problems	Monitoring studies/interviews indicate a reduction in growth in car usage Monitoring studies/interviews indicate relief in car traffic Monitoring studies/interviews indicate an improvement in air quality
Improving the land-use and urban growth patterns	Impact studies/interviews indicate an improvement and development at the city centre Impact studies/interviews indicate an improvement and development in declining areas Impact studies/interviews indicate an improvement in the pattern of urban growth

Based on the methodology presented, the next section measures the success of case studies in attaining the five objectives. Throughout the analysis, possible reasons for success or failure are discussed, and links are suggested between the success of the systems and the various factors reflecting their planning background and their planning process, which have been described in the previous chapter. After an evaluation of the overall success of systems, the chapter concludes with a summary of the factors that have affected the success of each system observed.

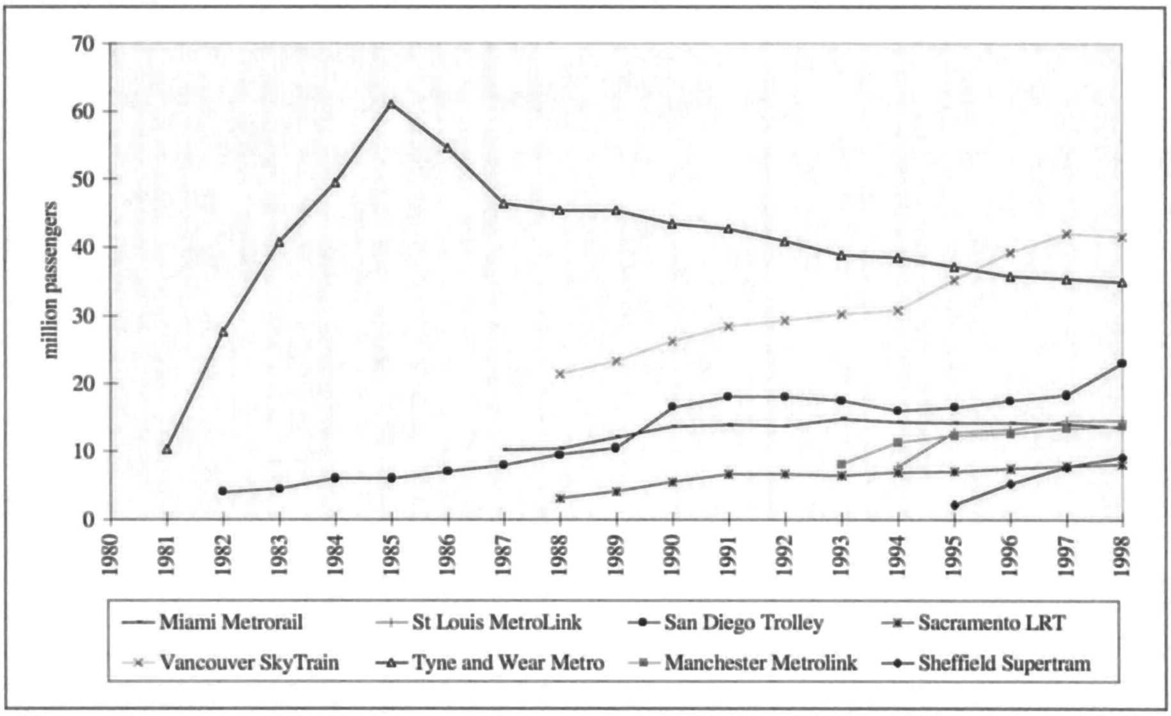
5.2 ATTAINMENT OF OBJECTIVES

5.2.1 Attaining a high level of patronage

Attaining a high level of patronage is not often identified by planners as one of the objectives; however, it is an important objective since it helps the attainment of almost all other objectives. In addition, the success and effectiveness of urban rail systems are often measured by indicators of patronage.

Patronage trends of the eight urban rail systems since their opening are shown in Figure 5.1. It is seen that the systems in Vancouver and Newcastle upon Tyne carry the highest number of passengers. It is noticeable that the patronage on Tyne and Wear Metro declined sharply after 1985, and is still in slight decline, while the patronage on Vancouver SkyTrain has been increasing since its opening. San Diego Trolley also has high patronage, which follows a steady increase. Miami Metrorail, St Louis MetroLink, and Manchester Metrolink closely follow the San Diego Trolley. Sacramento LRT and Sheffield Supertram have the lowest levels of patronage, but both systems, particularly the latter, have experienced increases in their patronage levels.

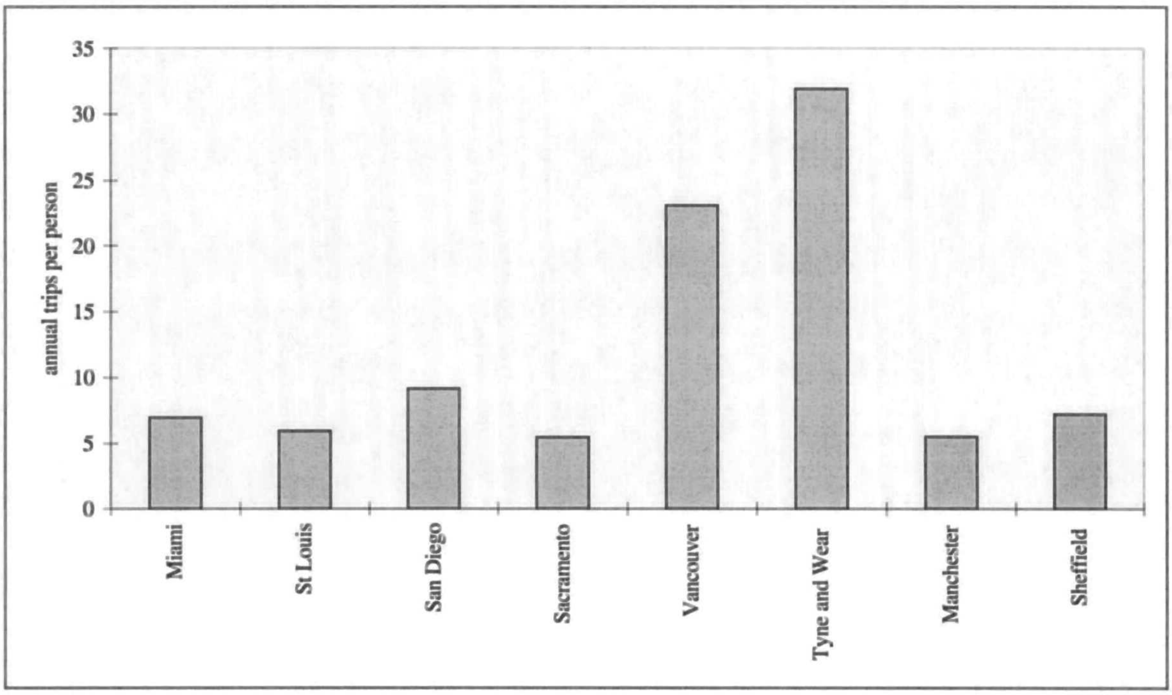
Figure 5.1 Patronage trends of the systems



Source: Department of the Environment, Transport and the Regions (1998b; 1999a); data provided by experts through interviews or documents; Federal Transit Administration (2000).

It will be remembered that the systems were selected from cities with populations between 500,000 and 3 millions. Figure 5.2 illustrates whether patronage analysis shows a different result when variations in population are taken into account. According to this diagram too, the best performing systems are Tyne and Wear Metro and Vancouver SkyTrain. The annual number of trips per person are fairly similar between the rest of the systems while Sacramento LRT and Manchester Metrolink have the lowest values.

Figure 5.2 Annual urban rail trips per person (1998)



Source: US Census Bureau (1999); Great Britain Office for National Statistics (1998a); Department of the Environment, Transport and the Regions (1999a).

These initial observations suggest that Tyne and Wear Metro and Vancouver SkyTrain are successful systems. However, each system is designed for different capacities, and different levels of patronage. Therefore the first figure should be considered only as an overall view of patronage levels on systems, and not as a measure of performance. Comparison of patronage per head of population also has its drawbacks. The scale of the systems, and their coverage of the urban areas and population are different. It will be remembered that the length of Vancouver SkyTrain system is similar to most of the systems, and much less than those in San Diego and Tyne and Wear; therefore, its high ratio of patronage to population indicates this system to be successful. Tyne and Wear Metro, on the other hand, is one of the most extensive systems; hence, it may cater for a larger proportion of the population. As a result, indicators that can incorporate the scale of the systems in the analysis should be used. The comparison of patronage with route kilometres seems to be a suitable indicator that can include the differences in the scale of the systems. Comparison of patronage with capacity can also yield important information on the utilisation of the services. In addition, vehicle load, which compares passenger kilometres with vehicle kilometres, reveals how well the service supplied is utilised. A final indicator is the comparison of patronage with the forecast levels, which shows whether the expectations were met. The performances of the systems using these indicators are shown in Table 5.2.

Table 5.2 Performance indicators in attaining high patronage (1998)

	Passengers per route km	Vehicle load: passengers per vehicle	Capacity used [1] (%)	Forecast and actual patronage [2] Projection year	Projected patronage	Actual patronage	Difference (%)
Miami Metrorail	408,561	17	11	1986	202,000	36,000	- 82
St Louis MetroLink	502,079	37	45	1993	13,000	24,515	+ 89
San Diego Trolley [3]	285,687	25	55	1981	9,500	12,000	+ 26
Sacramento LRT	273,725	21	33	1987	20,500	12,000	- 42
Vancouver SkyTrain	1,439,422	45	38	1996	100,000	136,000	+ 36
Tyne and Wear Metro	593,220	52	75	1985	219,000	208,900	- 5
Manchester Metrolink	445,161	28	33	1996	35,700	44,500	+ 25
Sheffield Supertram	317,241	13	37	1996	70,700	18,700	- 74
US average for metros	994,270	21	N/A				
US average for LRTs	341,068	26	N/A				
Canadian average for metros	2,916,667	N/A	N/A				
Canadian average for LRTs	1,241,096	N/A	N/A				
European average for LRTs	772,812	N/A	N/A				
Average of the case systems	496,205	32	35				

Source: Department of the Environment, Transport and the Regions (1999a); Federal Transit Administration (2000); data provided by experts through interviews or documents; for sources of country and continent averages, and the way these averages are calculated, see the Appendix.

Notes: N/A: not available.

(1) Capacity used is the ratio of average passenger trips per hour to the total passenger carrying capacity of the systems per hour.

(2) Forecast and actual patronage are the average weekday patronage. The projections have been made over different length of time, and this will affect the relative accuracy of the forecasts.

(3) San Diego Trolley was extended to the Mission Valley in November 1997; therefore, the figures show the system's performance after the extension. In 1997, before the extension, passengers per route kilometre were 279,185; passengers per vehicle were 24; and percent of capacity used was 44.

The number of passengers per kilometre of systems are highest for Vancouver SkyTrain. For most other systems, this indicator is much lower than that for the SkyTrain. Among them, Tyne and Wear Metro has high patronage, followed by the systems in St Louis, Manchester, and Miami. It is important to remember that the system in Miami is a metro, therefore has higher capacity and may be expected to carry more passengers.

Comparison of country and continent averages is useful in such cases since they provide comparison with other systems with similar technology. The average number of passengers per route kilometre of all metros that have been built in the United States since 1970 is slightly fewer than one million passengers. Compared to that figure, Miami metro is performing very poorly. As for the light rail systems in the United States, St Louis Metrolink is the only system that exceeds the US average. Vancouver SkyTrain too, is above the average for Canadian light rail systems. It is below the Canadian metro average; however, considering that the system is not a full metro and that it runs light rail vehicles, the system can be regarded as successful. As for the British systems, all three of them are below the average for new European light rail systems. To summarise, the systems in St Louis and Vancouver are the most successful ones for this indicator.

When the differences in the capacity of systems are incorporated in the analysis, Miami Metrorail appears to be the least successful system since only 11% of its capacity is utilised. The average of the eight systems is 35%; therefore, the systems in St Louis, San Diego, Vancouver, and Newcastle are successful by this criteria. The Tyne and Wear Metro is the most successful system according to this indicator; however, the original capacity of the system was reduced for financial reasons as mentioned in Chapter 4, Section 4.3.4. As a result, if the original capacity is considered, 38% of it is utilised, which would still be above the average of the case studies. (The average would also change and become 32.)

Vehicle load is another indicator of high patronage on the urban rail systems. This indicator represents the average number of passengers in each vehicle, and it is calculated by dividing the annual passenger kilometres by the annual vehicle kilometres. It is seen in the table that Tyne and Wear Metro and Vancouver SkyTrain have the highest number of passengers per vehicle, and they are followed by St Louis MetroLink. Sheffield Supertram and Miami Metrorail have the lowest number of passengers per vehicle.

A very common way of measuring success is comparing the patronage with the forecast. This is shown in the last columns of Table 5.2. According to this comparison, St Louis MetroLink is by far the most successful system since its patronage exceeded the forecast levels by 89%. In addition, Vancouver SkyTrain, San Diego Trolley and Manchester Metrolink are also successful: their patronage too exceeded the expected levels. Miami

Metrorail, Sacramento LRT, and Sheffield Supertram, on the other hand, all failed to attain the expected levels of patronage. Patronage of Tyne and Wear Metro was only slightly below that forecast.

It may be argued that the differences between the forecast and actual figures may be results of poor forecasting techniques, and optimistic forecasts, rather than the system's failure to attain them. On the other hand, in Miami and Sheffield, patronage fell over 50% below the forecast, while in Sacramento it was slightly below 50%. In these cases, it is clear that the patronage levels were very poor compared with the expectations.

Among the various patronage indicators discussed, passengers per route kilometre, vehicle load, and comparison of forecast and actual patronage are taken as the three main indicators that the criteria for success will be based on. These are the indicators which include the differences in systems design and expectations during their planning. Utilisation of the service supply is also covered by the vehicle load. Comparison of capacity used is not chosen as the main indicator because of the issues regarding Tyne and Wear Metro. For vehicle load too, Tyne and Wear Metro performs well, so the choice of vehicle load does not make Tyne and Wear Metro appear unsuccessful. In fact, the choice of indicators only affects the system in San Diego. San Diego Trolley appeared to be successful using the capacity indicator, whereas it is below the average using the vehicle load indicator. This issue should be borne in mind during the measurement of success.

Based on the three indicators chosen, three criteria are identified to determine whether the systems are successful or not. Table 5.3 shows the three criteria, and the performance of the systems in satisfying the criteria. The systems are given a tick for each criteria that they fulfil. If their number of passengers per route kilometre exceeds the average of the relevant country (US or Canada) or relevant continent (Europe), they are given a tick. For vehicle load, calculating averages has not been possible for Canada and Europe; therefore, the average of the case studies is used as the basis of comparison. Systems whose number of passengers per vehicle is higher than 32, which is the average of the case studies, are regarded as successful; therefore, they gain a tick. As for the comparison of forecast and actual patronage, systems are regarded as successful, hence given a tick, if their actual patronage exceeded the forecast patronage.

According to the above criteria, St Louis MetroLink and Vancouver SkyTrain are the most successful systems while the systems in Miami, Sacramento and Sheffield are not successful. San Diego Trolley, Tyne and Wear Metro and Manchester Metrolink do not perform very well either: they satisfied only one criteria.

Table 5.3 Performance of the systems in terms of patronage levels

	Passengers/ route km > relevant average	Passenger km/ vehicle km > 32 (the average of the case studies)	Actual patronage > forecast patronage	Overall success
Miami Metrorail				
St Louis MetroLink	✓	✓	✓	✓✓✓
San Diego Trolley			✓	✓
Sacramento Light Rail				
Vancouver SkyTrain	✓	✓	✓	✓✓✓
Tyne and Wear Metro		✓		✓
Manchester Metrolink			✓	✓
Sheffield Supertram				

One of the possible reasons for high patronage in Vancouver SkyTrain is the system's very high frequency, as shown in Table 4.9 in Chapter 4. In addition, residential density and public transport usage in Vancouver are high compared to the American cities; therefore, the urban setting may be more suitable for urban rail investment. On the other hand, both density and public transport usage in Vancouver are much lower than those in the British cities, so urban settings alone, do not explain the success of the investment. The municipalities' committed attitude towards developing the corridor that the SkyTrain runs through may also have effects on success. The corridor received substantial investment during the construction of SkyTrain, and was developed as the main corridor of commercial and residential development, which probably enhanced the patronage.

For the success of St Louis MetroLink, the most apparent factor is the location of the line and the stations. The city has historically developed along a radial corridor, and locating the light rail line along that corridor has provided the opportunity of penetrating many activity centres. Station locations were also very well planned to serve major activity centres in the city. In addition, some government buildings, and other developments built by public developers, such as sport stadiums, and a convention centre, were located at the MetroLink stations, so that they would help generate and attract trips on the system. Some operational issues may also have contributed to the patronage. For example, additional security staff on board and at stations, and the free-riding zone may have increased the attraction of the system. Another factor that is likely to have increased the patronage is the improvement of bus services in the city and their strong integration with MetroLink.

Tyne and Wear Metro cannot be considered to be unsuccessful in attaining a high patronage: its patronage per route kilometre is one of the highest, but compared to European systems it is not very high. As for the comparison of forecast and actual patronage, it fell short of the forecast by only 5%; therefore, its patronage can be considered almost as high as the forecast. As a result, the system is not unsuccessful. It has a fairly high patronage, probably because it is very extensive and serves many residential areas and employment centres (Figure 5.3). Besides, the urban area is very high density and consists of radial corridors which are suitable for public transport systems. The strong integration of the system with the buses during the initial years of its operation may be another reason for its success particularly in its first years. On the other hand, the patronage of the system has declined since 1986, as Figure 5.1 shows. The decline may be partly because of the deregulation of buses; however, factors internal to the economy of the city, and increasing car ownership and usage may also have played a part in the decline of the system's patronage. In addition, recent developments and municipal plans are not very supportive of the Metro as described in Section 4.5.6 of Chapter 4.

Like the Tyne and Wear Metro, Manchester Metrolink also has a fairly high patronage per route kilometre, but it is not very successful when comparison is made with European light rail systems. On the other hand, it was successful to some extent since its patronage exceeded the forecast. The urban area with its radial corridors and high public transport usage may have contributed to the patronage of the system. In addition, the location of the system was very suitable. It will be remembered from Section 4.3.3.7 of Chapter 4 that the system was located at two corridors that served well-developed residential areas where a considerable level of rail commuting patronage already existed (Figure 5.4). On the other hand, the previous rail patronage along the

Figure 5.3 Alignment of Manchester Metrolink trough well-developed residential areas

Figure 5.4 Location of Tyne and Wear Metro trough well-developed residential areas

corridors, which was 7.6 million, increased to 12.06 million after the opening of Metrolink (Knowles, 1996). Providing a more frequent service compared to the previous rail service, providing access through the city centre, and the positive image of a new tram system may be among the contributory factors.

San Diego Trolley is also measured here as one of the less successful systems in terms of patronage. It will be remembered, however, that it was measured to be successful in the capacity indicator: an important proportion of its capacity is being utilised. In addition, in the United States, it has a very good reputation for having high patronage. Since its opening, the Trolley has been extended continuously: it is the most extensive system studied here. In its initial years before the extensions, the system had a very high patronage compared to its length. It will be remembered from Section 4.3.3.3 that the first line, the South Line, was chosen because it was a corridor where there was existing public transport patronage, and where potential for attaining high light rail patronage was the greatest. The extensions, on the other hand, mostly serve residential areas, where the system is used at peak times for commuting purposes. Therefore, although the South Line of San Diego Trolley had a very good reputation for high patronage, which justified the extensions, the extensions have not been as productive as the initial line. For example, in the year 1995, when the South Line had not been extended towards the Northern settlements, it was carrying approximately 65% of the patronage on the Trolley. It was carrying 424,211 passengers per every kilometre of its route, while the East Line was carrying only 173,393 passengers per route kilometres. To conclude, San Diego Trolley does not appear to be very successful in terms of its patronage, but it should be remembered that in earlier years it performed very well in attaining high patronage, and that the decline in its performance is not a result of a decline in its patronage as in Tyne and Wear Metro, but a result of the new extensions, which are not as profitable as the initial line because of the nature of the areas they serve.

The reasons for the good performance of San Diego Trolley during its initial years of operation appears to be mainly because of the suitable location of the line, as mentioned above. In addition, the good integration of the project with the city centre redevelopment plan may have helped the system because the system was designed to serve many attraction centres while the project was adapted to the Trolley, and it located many new activity centres at Trolley stations.

Three of the systems observed here were found to be unsuccessful in terms of attaining high patronage. They are Miami Metrorail, Sacramento Light Rail, and Sheffield Supertram. There are several factors which seem to have hindered the success of these systems.

Interviews, fieldwork, and other supporting documents have shown that the failure of the systems in Miami and Sacramento were mostly associated with the very low density urban area. In Miami, the city has sprawled at a very low density, and the urban area is very unsuitable for a single-line heavy rail system to be successful. The system covers a very limited area, and serves only a few of the many activity centres in the city. The southern line serves some retail centres which are not the most suitable type of urban activity for public transport. The northern line, in contrast, serves a low income residential area which relies on public transport. However, the system failed to become the main transport mode of the citizens in that area. There have been three reasons for this. First, in initial years of operation, trips on Metrorail cost more than trips on buses. Second, there are transfer fares between buses and urban rail system, which may discourage low income residents from using the system. Third, the inhabitants of the northern parts of the city had a very strong and negative reaction to the building of the Metrorail. In Chapter 4, the way in which the construction of the system had negative external effects on some neighbourhoods was described. A result of this was that the local image of the Metrorail remained poor.

In addition to these factors which seem to have affected the success of Miami Metrorail in general, there were other factors which prevented the system from attaining its forecast patronage. It was stated by the planners interviewed that the patronage of the system was predicted under the assumptions that the bus systems would be reorganised and improved, service levels and especially the frequency of trains would be improved continuously, and well-enforced car restriction measures would be introduced in the city centre. In Section 4.5.1 in Chapter 4, there was discussion on how these supporting measures could not be introduced for financial and political reasons.

Sacramento has urban problems similar to Miami: housing is very low density, and urban sprawl is the dominant form of growth. Urban activity centres are spread across the city;

therefore, there are no corridors with concentration of activity centres, which would be suitable alignments for public transport systems. In addition to the unsuitability of the urban area for public transport in general, the location of the lines which were described in Chapter 4, appear not to be very convenient. The northern line parallels one of the main highways of the city for most of its route: many stations do not serve any activity centres or residential areas, only park-and-ride facilities (Figure 5.5). The eastern line, which is called the Folsom Line, is more convenient in the sense that it penetrates some residential areas; however, such areas are very low in density. In addition to these issues, financial problems prevented high service levels on the system, and to some extent limited the level of integration with buses. Service levels still appear to be poor: the frequency of trains is every 15 minutes all day, including peak times, which is the lowest frequency among the systems observed here (Table 4.9). As for integration with buses, it was improved during the initial years of operation, which may be a reason why patronage increased significantly during the first four years. The forecast level for the year 2000 was attained in the mid-1990s; however, patronage indicators show that the patronage of the system is still not very high.

In Sheffield, in contrast to Miami and Sacramento, the urban form seems to be suitable for urban rail investment. The residential density is at medium-high levels, and public transport usage in the city is high (Table 4.3). One common argument among experts is that the areas served by the Supertram were not the neighbourhoods of the target population for light rail system (Figure 5.6): they are low income areas where residents are more likely to use buses. The lines and stations were also criticised as not being able to penetrate the residential areas and other activity centres, such as retail centres, along the line (Fox, 1996). In addition, the high frequency of stops and predominant street running sections without full priority in signalling seem to have decreased the speed and reliability of the system. The disadvantage of poor service levels were further increased by competition from buses. A final factor that affected the patronage of the system appears to be the lack of co-ordination between planning agencies. A number of high density residential blocks, which the tram was designed to serve, have been demolished during the construction of the system, as mentioned in Chapter 4, section 4.5.8.

Figure 5.5 Location of Sacramento Light Rail along a highway

Figure 5.6 An example of the areas served by Sheffield Supertram: a low income neighbourhood

5.2.2 Building and operating the system cost-effectively

Cost-effectiveness is a very frequently used indicator to determine whether or not new public transport systems are successful, and whether it is worthwhile to build them. In Table 5.4, the case studies are analysed against some financial indicators. The most expensive system to build was the one in Miami, followed by those in Vancouver, San Diego, and Tyne and Wear, and the cheapest were in Sacramento and Manchester. When the capital costs are annualised (over 30 years at 8%), and compared with the annual patronage, however, it is seen that the investments in Vancouver and Tyne and Wear were well judged. The high level of patronage justifies the high capital cost. In Miami, on the other hand, patronage is not sufficient to justify the high cost investment. In San Diego, because some of the investments were very recent, their utilisation is not as high as in Vancouver, but it is much lower than that in Miami. Sheffield Supertram, although not significantly more expensive than the light rail systems in the US, has a value which is higher than most of the systems, because its patronage is poor. Manchester Metrolink appears to be the most cost-effective system, since its capital cost was low and patronage high. Data is available for calculating average values for other systems that were built in the same country or continent as the case study systems. According to this, Miami Metrorail performs poorly since the ratio of its capital cost to its patronage exceeds the average ratio for the US metros, which is £3.63. The American light rail systems perform well since their ratio of capital costs to patronage is below the US LRT average which is £3.10. Vancouver SkyTrain is also a cost-effective system compared to other light rail systems in Canada. The systems in Manchester and Tyne and Wear also perform well; however, Sheffield Supertram is far above the European average of £1.29. To summarise, all systems, apart from Miami Metrorail and Sheffield Supertram, are cost-effective systems from the point of the cost of construction.

The ratio of operating cost to the number of passengers carried is another indicator frequently used to measure cost-effectiveness. This ratio is the lowest for the systems in Vancouver, Manchester, San Diego, and Tyne and Wear. St Louis MetroLink too seem to be efficient. The low values of operating cost per passenger for the Vancouver SkyTrain and Tyne and Wear Metro seem to be a result of the high patronage of these systems, because their operating costs are among the highest observed here: £22 millions and £27 millions respectively. As for Manchester Metrolink, its good performance is a result of both high numbers of passengers, and low levels of operating cost. Sacramento Light Rail and Sheffield Supertram do not perform very well although they have relatively lower total operating costs: £9.7 millions and £9 millions respectively. In addition to them, Miami Metrorail has a poor performance, having the highest operating cost, £32 millions, and poor patronage. (See Appendix for total operating costs.)

Table 5.4 Financial performance of the systems (1998[1])

The systems in:	Capital cost (£) (in 1998 prices)	Annualised capital cost [2] per passenger (£)	Operating cost per passenger (£)	Total annual cost per passenger (£)	Passengers per staff member	Fare revenue per passenger (£)	Farebox recovery ratio (%)
Miami	1,058,285,200	6.46	2.40	8.85	31,949	0.67	29
St Louis	259,738,400	1.47	0.87	2.33	91,574	0.37	46
San Diego [3]	609,386,900	2.18	0.76	2.94	55,347	0.55	68
Sacramento	164,725,600	1.68	1.20	2.88	52,777	0.49	40
Vancouver	843,383,500	1.67	0.53	2.19	119,196	0.19	38
Tyne/Wear	533,216,600	1.25	0.76	2.02	53,354	0.58	77
Manchester	175,659,500	1.05	0.69[4]	1.71	69,000	0.99	143[3]
Sheffield	271,074,300	2.42	1.15	3.40	36,800	0.60	52
US average for metros		3.63	1.39	4.78	43,257	0.29	27
US average for LRTs		3.10	1.33	4.43	44,077	0.37	25
Canadian average for metros		N/A	N/A	N/A	N/A	N/A	N/A
Canadian average for LRTs		1.73	N/A	N/A	N/A	N/A	N/A
European average for LRTs		1.29	N/A	N/A	N/A	N/A	N/A
Average of the case systems		2.03	0.88	2.84	60,939	0.49	56

Source: Department of the Environment, Transport and the Regions (1998b; 1999a); data provided by experts through interviews or documents; Federal Transit Administration (1999; 2000).

Notes: US Dollars and Canadian Dollars are converted to English Sterling using Purchasing Power Parities index provided by the OECD (1999).

N/A: not available.

(1) Fare revenue and farebox recovery ratio are based on 1997 data.

(2) Capital costs are discounted to the year 1998, and annualised over 30 years at 8%.

(3) Performance indicators for San Diego Trolley include the latest extension to the Mission Valley. Before the extension, in 1997, annualised cost per passenger was £2.03; operating cost per passenger was £0.76; total annual cost per passenger was £2.85; and passengers per staff member were 57,325. The differences between the 1997 and 1998 data are not significant, and the overall performance of the system in comparison with the relevant averages does not change when 1998 data is used.

(4) Operating cost data for Manchester is based on its performance in 1996 reported by Knowles (1996) since operators keep operating cost data confidential.

The analysis of capital cost and operating cost together, as shown in Table 5.4, shows that Miami Metrorail is a very inefficient system, and that the high costs incurred for its construction as well as its operation are not justified by its very low patronage.

In addition to the cost issues, passengers per staff member are examined as an indicator of efficiency. Vancouver SkyTrain has an outstanding value for this indicator, probably because it is an automatic system. The trains are operated without drivers, and this must have caused the number of staff to be low. The system in St Louis is also very efficient, followed by those in Manchester, San Diego, Newcastle, and Sacramento, although the performance of the latter three is below the average of the eight systems. The figures clearly show that Miami Metrorail and Sheffield Supertram are not efficient.

The last two columns of the table show the profitability of the systems. Fare revenue per passenger is highest for Manchester. It will be recalled that the fares of Manchester Metrolink are the most expensive compared to other systems observed here (Table 4.10). High fares, as well as the fact that the central government insisted that the system be operated without subsidy (Senior, 1999) may explain the success of Manchester in fare revenue related indicators. Miami Metrorail appears successful by this indicator. Another remarkable point is that Vancouver SkyTrain has the lowest value for this indicator although it performs very successfully in all other indicators of cost-effectiveness. There may be several factors for the low value in Vancouver and for other variations between the rest of the systems including the number of people travelling on reduced and through fares and how the revenue is allocated.

In addition to the comparison of fare revenues with passengers, the ratio of fare revenue to operating cost is an important, and a very common method of measuring financial performance. The British systems are notably successful in this indicator which is shown in Table 5.4 under "farebox recovery ratio". This may be the result of deregulation of buses: in North American cities fare revenues are allocated between different public transport operators while in Britain, revenue allocation is not common due to the deregulation of buses outside London. In addition, public subsidy for operation, which is very common for North American systems, is strongly discouraged by Central Government policies in the UK. Among the North American systems, San Diego Trolley appears to be successful, since it recovers 68% of its operating cost, while this ratio is below 50% for other American systems. Indeed, San Diego Trolley has been a very cost-effective system, particularly during the initial years of operation when the system was not as extensive as it is today. Until the mid-1990s, the cost recovery ratio was always above 70%, with the highest recovery ratio of 95% in the year 1989 (Wahl and Humiston, 1992), when the majority of the Eastern Line was also in service.

Among the above indicators, three of them are selected for use in measuring the financial performance of the systems. Annualised capital cost per passenger is chosen as one of the indicators because data is available to provide comparisons with other systems in North America and Europe. Besides, the analysis of capital cost in relation to the patronage is a common method of measuring the financial performance of urban rail investments. Secondly, operating cost per passenger is chosen because this indicator is also frequently used to measure the cost-effectiveness of systems. Passengers per staff member is not included as one of the indicators since it is a measure quite similar to operating cost: personnel cost is generally the highest cost component in the total operating cost. Indeed, the observations of the performance of systems in operating cost per passengers are quite similar to those in staff-passenger ratio. Fare revenue per passenger and farebox recovery ratio are also similar to each other to some extent, and among them the latter is chosen.

Table 5.5 shows the criteria for the systems to be regarded as successful. For the annualised capital cost per passenger, data is available to make comparisons with country and continent averages: systems are accepted to be successful if their annualised capital cost per passenger is below the relevant average. For operating cost per passenger and farebox recovery ratio, it is has not been possible to obtain data to calculate averages for countries and continents. Therefore, the average of the case studies is used: systems are accepted to be successful if they perform well compared to their own average.

Table 5.5 Performance of the systems in terms of cost-effectiveness

	Annual capital cost/passenger <average	Operating cost/passenger < £0.88 (the average of the case studies)	Fare revenue / operating cost (farebox recovery ratio) > 56%	Overall success
Miami Metrorail				
St Louis MetroLink	✓	✓		✓✓
San Diego Trolley	✓	✓	✓	✓✓✓
Sacramento Light Rail	✓			✓
Vancouver SkyTrain	✓	✓		✓✓
Tyne and Wear Metro	✓	✓	✓	✓✓✓
Manchester Metrolink	✓	✓	✓	✓✓✓
Sheffield Supertram				

The results indicate that San Diego Trolley, Tyne and Wear Metro, and Manchester Metrolink are the most cost-effective systems, followed by St Louis MetroLink and Vancouver SkyTrain. Miami Metrorail and Sheffield Supertram are the least successful systems in financial terms.

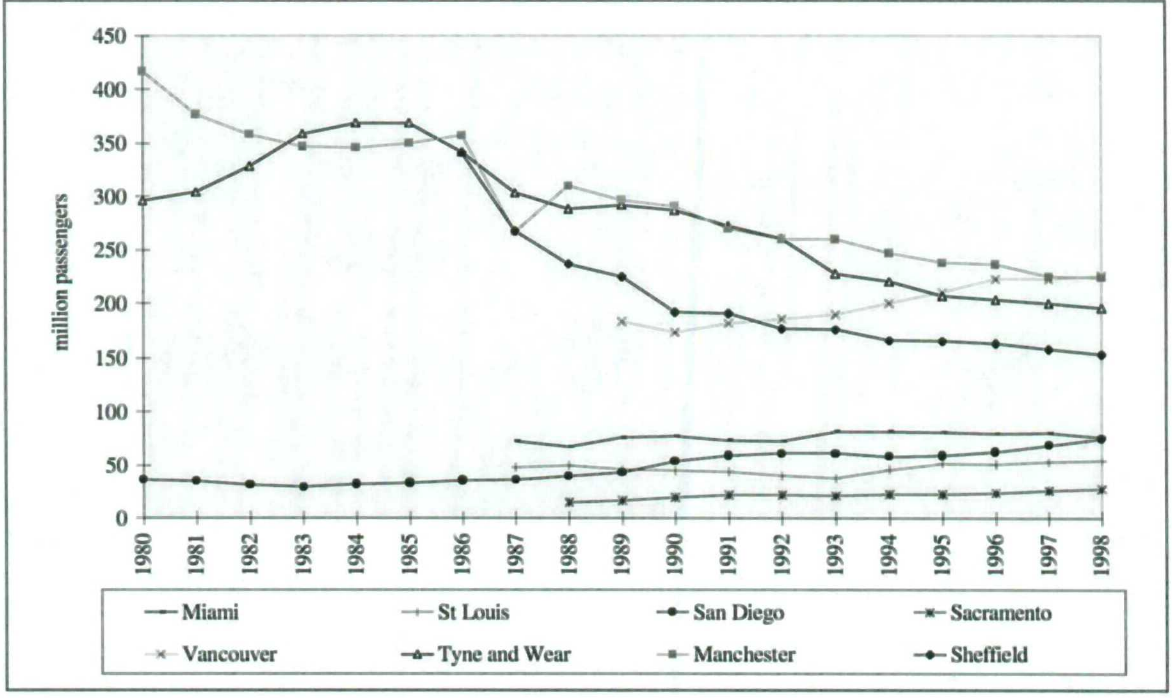
The analysis of financial performance reveals an important point. The fact that the urban rail system operators in Britain do not share their farebox revenue with bus operators seems to be a factor that enhances the profitability of systems, except in cases, such as Sheffield Supertram, where patronage is very poor. On the other hand, separate farebox revenues cannot be considered to be a factor contributing to the overall success of systems because it is a consequence of lack of fare integration between buses and urban rail systems, which has negative effects on the attraction and consequently the patronage of systems.

5.2.3 Increasing public transport usage

Improving public transport services and increasing the overall usage of public transport have been a primary objective for all eight of the systems observed. The most effective way of observing whether the new systems had a significant impact on the level of public transport usage is by analysing the effects on modal share. If the modal share of public transport increased after the opening of a new urban rail system, this would indicate success. However, impact studies and interviews with experts revealed that impacts of systems on modal split of transport modes were negligible. One reason may be that the introduction of the urban rail systems was not followed by car restriction policies in any of the cities.

As an alternative way of observing the impacts of new systems on public transport usage, trends in public transport patronage are analysed over time, in Figure 5.7. In Newcastle upon Tyne, Manchester, and St Louis, there was an increase in public transport usage after the opening of the systems. However, it is difficult to attribute increases in public transport usage only to the new urban rail systems. Increases are, to some extent, the results of improvements in the bus systems, which in the North American cities and in Newcastle upon Tyne, accompanied the introduction of the urban rail systems. In addition, increases may be caused by other factors that resulted in increased mobility in the urban area. As a result, the figure is not sufficient for observing the impacts of systems; alternative measures must be used in order to judge whether these systems contributed to total public transport usage.

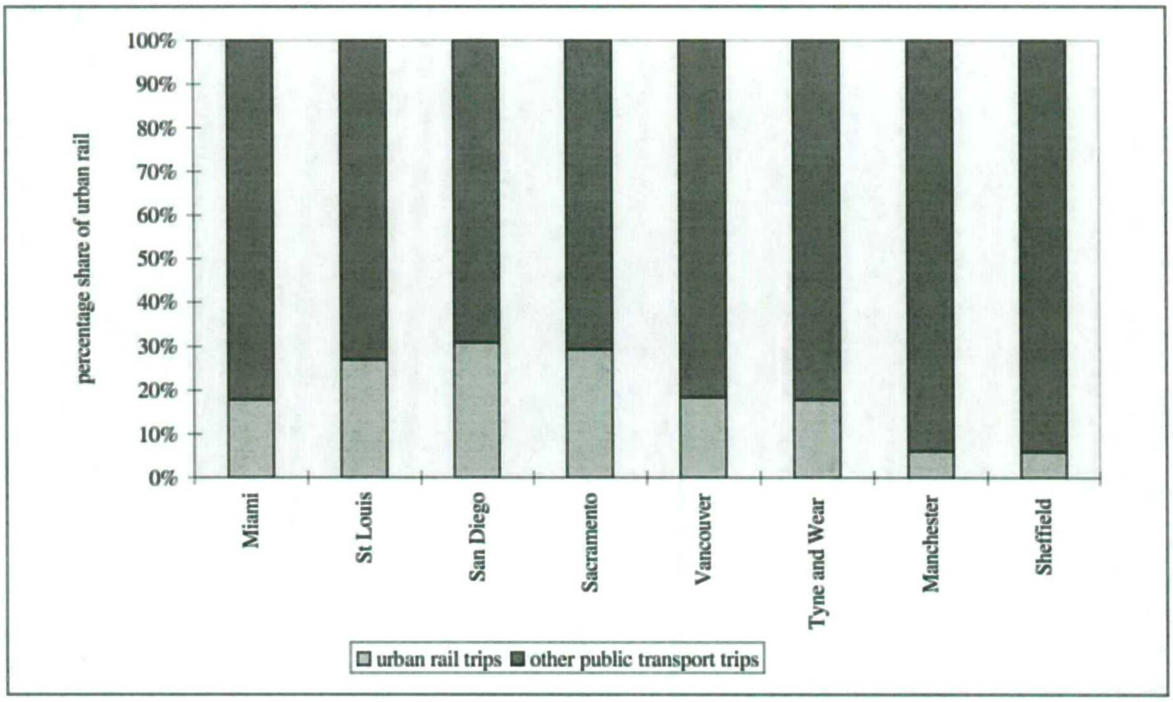
Figure 5.7 Public transport usage in the eight cities



Source: Department of the Environment, Transport and the Regions (1999a; 1999b); Federal Transit Administration (2000); data provided by experts through interviews or documents.

One way of analysing the contribution of new systems to total public transport usage is by examining the share of urban rail system trips in total public transport trips. It is shown in Figure 5.8 that in most of the American cities, trips made on the new systems are more than a quarter of the total public transport trips. The figure indicates that these systems are an important part of the public transport system; however, it would be misleading to conclude that they are more successful than the others. That is because, in the British cities and in Vancouver, where the share of urban rail trips in total public transport is below 20%, public transport usage is significantly higher than that in the American cities (Figure 5.7). Therefore, the introduction of new urban rail systems does not have such a significant effect on total public transport patronage, as it does in the American cities. Comparison of Manchester Metrolink with Sacramento Light Rail provides a good example. Manchester Metrolink carries almost double the number of passengers that Sacramento Light Rail carries; however, patronage on Manchester Metrolink forms only 5% of total public transport patronage in Manchester while patronage on Sacramento Light Rail is 30% of total public transport patronage in Sacramento. As a result, analysing the modal share of public transport modes does not seem to be a very suitable way of measuring success either.

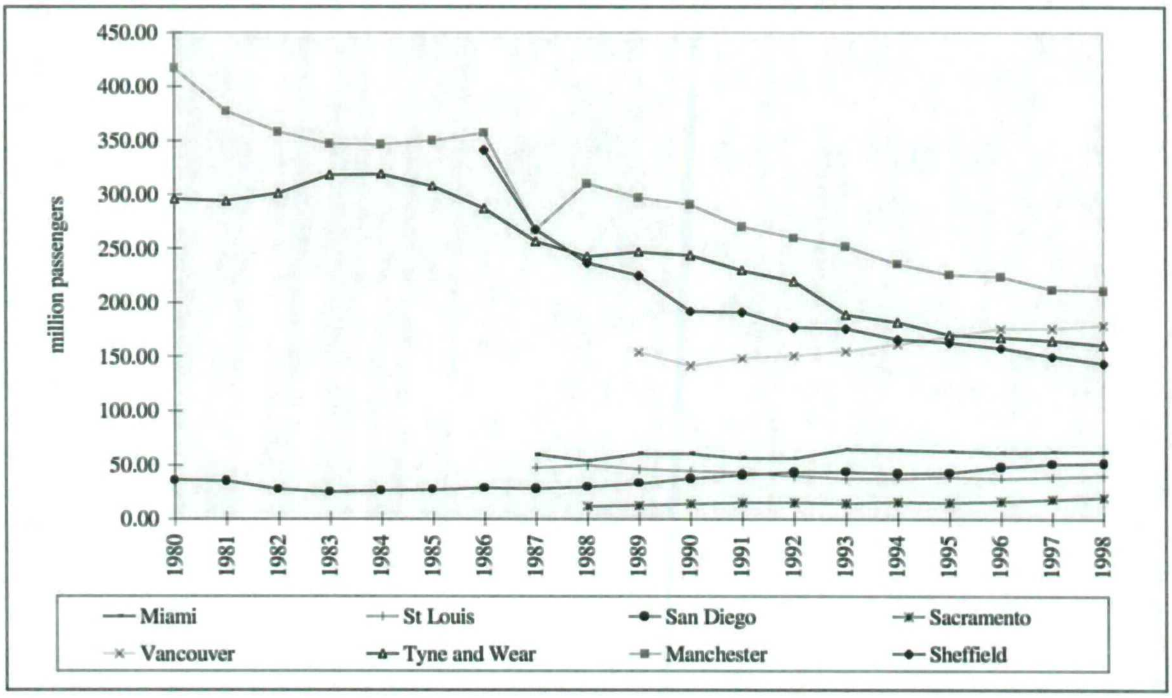
Figure 5.8 Share of urban rail trips in total public transport trips (1998)



Source: Department of the Environment, Transport and the Regions (1999a; 1999b); Federal Transit Administration (2000); data provided by experts through interviews or documents.

The discussions above show that measuring the effects of new urban rail systems on total public transport is not very easy, and that the use of some indicators can be misleading. As a result, three indicators are identified. The first indicator, as mentioned earlier, is based on the modal share of public transport of total motorised trips before and after the opening of the urban rail systems. An increase in the modal share has not been observed in any of the cities. However, this is not a reason for not using this indicator; on the contrary, it should be included so that the failure of systems in increasing the share of public transport trips can be included in the analysis. The second indicator is identified as the patronage trend of the urban rail systems. It is potentially misleading to use indicators that compare the patronage on urban rail systems with the total public transport patronage as discussed before; therefore, it is considered that if the patronage on the urban rail systems is increasing, this should be accepted as a positive sign in terms of public transport usage. This is not as strong an indicator as the previous one; however, it is likely that an urban rail system whose patronage is declining cannot have any strong positive impact on public transport, while a system with increasing patronage bears the potential of enhancing the overall public transport usage. On the other hand, it is important to be aware that the patronage of urban rail systems may sometimes be at the expense of the patronage of buses. The third indicator, therefore, is the trend of bus patronage (Figure 5.9). The urban rail systems are accepted to be successful if they did not cause a decline in bus patronage.

Figure 5.9 Bus patronage trends in the eight cities



Source: Department of the Environment, Transport and the Regions (1999b); Federal Transit Administration (2000); data provided by experts through interviews or documents.

Table 5.6. shows how the eight urban rail systems perform according to the three criteria. None of the systems resulted in an increase in the modal share of trips made on public transport. On the other hand, most of the systems have steadily increasing patronage. Only Tyne and Wear Metro and Miami Metrorail experience decline in their patronage. The patronage of Tyne and Wear Metro has been declining since 1985 while the patronage of Miami Metrorail has been in decline since 1993. For systems where patronage is increasing, the increases do not seem to have caused a decline in the patronage of buses. Figure 5.9 shows that in none of the North American cases, bus usage has declined after the opening of the urban rail systems, probably because bus services have been strongly integrated with the urban rail systems in both routes and fares. In St Louis, in particular, the introduction of the light rail system was accompanied

by a radical improvement in buses: bus routes were shortened and simplified, and specially painted buses were introduced in some routes for the easy recognition by customers (Figure 5.10). In British cities, bus usage is declining; however, new systems do not seem to be responsible for that. In Manchester and Sheffield, the declining trend became neither steeper nor steadier after the opening of the systems. Bus patronage is very high, although declining, and any effects of the new systems are only marginal. In Newcastle upon Tyne, however, bus patronage trend until the mid-1980s seemed to be steadier, perhaps because of the strong integration with the Metro until 1986, and after 1986 experienced significant decline. The trend is perhaps not only related to the integration with Metro: bus deregulation may have played an important role. As a result, Tyne and Wear Metro does not seem to be responsible for the decline in bus usage either.

Table 5.6 Performance of the systems in increasing public transport usage

	Modal share of public transport increased	Patronage of the system is increasing	New system did not cause decline in bus usage	Overall success
Miami Metrorail			✓	✓
St Louis MetroLink		✓	✓	✓✓
San Diego Trolley		✓	✓	✓✓
Sacramento Light Rail		✓	✓	✓✓
Vancouver SkyTrain		✓	✓	✓✓
Tyne and Wear Metro			✓	✓
Manchester Metrolink		✓	✓	✓✓
Sheffield Supertram		✓	✓	✓✓

According to the indicators identified, Miami Metrorail and Tyne and Wear Metro are the least successful systems, because their patronage is declining. Systems that experience an increase in their patronage, and that did not cause a decline in bus patronage, are the successful ones. None of the systems can be claimed to be very successful since none of them have satisfied all three of the criteria. None of them were able to increase the modal share of public transport.

Figure 5.10 The Bee-Shuttle in St Louis: specially painted for easy recognition

5.2.4 Preventing or solving traffic congestion and associated environmental problems

The impact of urban rail systems on car traffic and environment are measured by three criteria. Systems are regarded as successful if they reduce growth in car usage, reduce traffic congestion, and improve air quality. There is no evidence that the systems reduced growth in car usage, or reduced car traffic. Experts interviewed noted some relief of traffic congestion across river bridges in Vancouver and St Louis, two systems that provide access over rivers. However, the impact was not strong enough to affect traffic levels along the whole corridor. Moreover, it was anticipated that relief was short term, and that it might have attracted new car users.

Manchester Metrolink has contributed to some reduction in car traffic on parallel routes; however, the influence of other factors, such as major road works, need to be considered as part of the explanation of traffic reductions (Knowles, 1994). In Newcastle upon Tyne, when the metro opened for service, radical changes were made to bus routes. Bus mileage to Newcastle city centre was reduced by 35%, and area-wide bus mileage by 9% (Tyne and Wear Passenger Transport Executive, 1985). The reductions might have resulted in relief in traffic congestion; however, the routes were altered again after the deregulation of buses after 1985.

It has not been possible to analyse the effects on air quality. Air quality monitoring has not been made in any of the cities after the opening of the systems. However, it is anticipated that the effects of the systems on air pollution levels are negligible because journeys made on these systems represent less than 3 % of the total motorised trips, and in none of the cities, was there an evidence of reduction in car traffic after the opening of the systems.

As a result, it is concluded that this objective has not been attained by any of the eight systems observed.

5.2.5 Improving the land use and urban growth patterns

In order to determine whether the systems had positive impact on land-use and pattern of urban growth, three sub-objectives are observed: stimulating development at the city centre; stimulating development in declining slum areas; and improving the pattern of urban growth by transforming it from a car-oriented to a more public-transport-friendly pattern. Criteria for measuring the success of systems are based on these sub-objectives. If the systems are observed to attain the three sub-objectives, they will be regarded as successful in attaining the main objective.

As described in Chapter 3, the North American cities were visited in June 1997, and the British cities in March and August 1998. The analysis, therefore, does not include the land-use impacts of the systems after these dates. The Mission Valley extension of San Diego Trolley and the Salford extension of Manchester Metrolink, for example, are not included in the land-use impact analysis.

5.2.5.1 Stimulating development at the city centre

Reinforcement of the city centre by stimulating new development has been an important objective for most of the urban rail systems observed. Among them, St Louis MetroLink and San Diego Trolley had the most significant effects on their city centres. In St Louis, the improved access, the positive image of the light rail system, and the free-riding zone policy which provides free journeys on the light rail system between six city centre stations at off-peak times, are believed to have improved the mobility in the city centre, and made it more attractive for developers. It was claimed by planners that the retail turnover in the city centre has increased, and the decentralisation of the central business district (CBD) has slowed down since the opening of MetroLink. It will be remembered from Chapter 4 that the metropolitan planning agency initiated some development, such as retail centres, sports stadiums, and convention centres, at city centre station sites. There have also been some developments in the city centre stations in order to convert under-used developments to shopping and leisure centres. In addition to developments by public agencies, tax incentives have been used in order to attract private sector developers to the city centre. Development has been stimulated in the city centre although development also continues in areas that the commercial and retail growth trends reinforce. Clayton Centre is one of these areas. As described in Chapter 4, section 4.3.3.2, MetroLink has not been planned to serve the Clayton Centre in its initial phases in order to avoid the further decline of the CBD. It appears that this policy may actually have helped the CBD to improve.

San Diego is another city where the city centre benefited from the urban rail investment. The city centre of San Diego is very different from the majority of American city centres in that it does not suffer from economic decline or loss of population. This is due to the aforementioned redevelopment of the city centre area since the late 1970s, which has been carried out by the City of San Diego, the municipality which covers the city centre. The city centre segments of the Trolley are well integrated with the redevelopment project: many Trolley stops were designed to serve new residential blocks (Figure 5.11) and shopping centres. In addition to the redevelopment project, as described in Chapter 4, the municipality used several transit oriented development (TOD) incentives to encourage developers to locate close to the Trolley line, for example, tax reductions and relaxation of car parking requirements. The latter incentive also led to a reduction in the number of car parks in the city centre. Recently, a new shopping centre has been opened in the CBD which did not provide any car parks. The developer justified the lack of car parks with the fact that his facility was close to a Trolley stop (Stepner, 1997).

In Newcastle and Manchester too, the systems had positive effects on the city centres. In Newcastle, the Metro had effects on the location of commercial and retail activities as well as on the importance of the CBD in the region. After the opening of the Metro, the retail and commercial centre moved northwards, around Monument and Haymarket stations of the Metro. This was not solely due to the existence of the Metro, but also to the city centre redevelopment and pedestrianisation projects, which concentrated around these two stations. The environmental improvement and new developments, particularly retail, strengthened the Newcastle city centre, and eventually helped it become a regional centre. On the other hand, areas around other city centre Metro stations, such as the St James Park Station, have not experienced any improvement. This appears to be a good demonstration that Metro alone was not enough to induce environmental improvements, but that it was effective when well supported with urban renewal projects. Recently, central activities at Monument and Haymarket stations have also been suffering loss of business. The Metro Centre, a large out-of-town shopping centre built in the Enterprise Zone, has been severely affecting the vitality of the Newcastle CBD.

Figure 5.11 A new condominium in San Diego city centre: well served by the Trolley

In Manchester, the most notable impact of the system on the city centre is that leisure trips to the city centre increased. Metrolink provided the city centre with the rail access that the city had been seeking for more than a century, and it is assumed that the improved accessibility as well as improved service frequency along the corridors increased the number of people travelling to the city centre. Developmental impact, on the other hand, is more difficult to identify. Most of the northern parts of the city centre remained derelict in spite of the Metrolink access, whereas the central and the southern parts of the CBD benefited from increased business, retail, and leisure activities. The advantageous situation in these latter areas was due to the refurbishment of many city centre buildings (some of these were as a result of the 1996 bomb attack), pedestrianisation schemes in the city centre, the activities of the Central Manchester Development Corporation, and the influence of southern prosperous suburbs on the southern parts of the city centre. Knowles (1994) suggests that the Metrolink accessibility reinforced these advantages, but that in the absence of such favourable factors, it did not have significant effects.

Among the other systems, which had negligible effects on the city centres, Vancouver SkyTrain is different because the city centre of Vancouver has always been a powerful commercial and retail centre. Hence, reinforcing the city centre was not among the objectives of the SkyTrain. However, it was planned to be used as an instrument for creating mixed-use development in the city centre. SkyTrain stations were rezoned as the main concentrations of commerce and office development, and other areas for residential areas and recreational places. This policy was introduced to prevent the CBD from being occupied only by commerce, and it appears that the SkyTrain proved to be a useful instrument in the realisation of the policy.

In Miami and Sacramento, urban rail investments had negligible effects on the city centres. In Miami, hotels were built at the vicinity of some city centre stations, but only at those that were close to places of tourist attraction. In general, the city centre is in severe economic decline. As mentioned in Chapter 4, TOD initiatives, such as reduction in car parking requirement at sites close to the metro stations, were offered; however, they were not as effective as they were in San Diego. Developers did not want to provide less parking space because they considered parking to be an important marketing tool for selling their property. In Sacramento, there has been a slight impact: retail activity increased at a pedestrianised city centre street where the light rail system runs through. In addition, the Capitol Area Development Authority (CADA) is investing on several sites in the city centre for medium density multi-family housing. Although some of these houses have been built, their interaction with the LRT and its stops is very limited. It is difficult to suggest that the LRT was an instrument in the CADA project, or that the CADA project helped the LRT patronage.

The impacts of Supertram on the Sheffield city centre seems rather controversial. On the one hand, the design and construction of Supertram along the city centre streets led to some piecemeal urban design projects and environmental design improvements in city centre squares. These improvements and the existence of Supertram affected the image of the city: it is stated in a fact sheet of Light Rail Transit Association, that conditions for pedestrians as well city shoppers have significantly improved (Light Rail Transit Association UK Development Group, 1997). On the other hand, the location of the first line may have detrimental effects on the city centre. The first line connects the city centre with the Meadowhall shopping centre, which is a very large out-of-town shopping centre and a very powerful threat to the survival of the city centre. Since the opening of the Meadowhall, the city centre retail turnover has declined by 35% (Rowley, 1995). Having a line from the city centre to the Meadowhall was probably beneficial for Supertram in terms of patronage; however, it may have contributed to the economic decline of the city centre, which in addition to many economic factors, has been caused by the Meadowhall shopping centre. It must, however, also be noted that to build such a powerful regional shopping centre at a distance of 4 km from a city centre that is in an economic decline was the major mistake, and that the impact of having the Supertram line to this shopping centre may have been a marginal one.

It is useful to compare the planning backgrounds of Sheffield Supertram with St Louis MetroLink. Similar to the Meadowhall Centre of Sheffield, the Clayton Centre has developed in St Louis as a new office centre outside the city centre. Growth trends strongly favoured the Clayton Centre, and having MetroLink access to that site would probably increase the patronage. However, as mentioned earlier, the planners did not include a link to the Clayton Centre in initial stages, and postponed it until the third phase of Metrolink when improving the accessibility of Clayton would not harm the city centre. The comparison of Sheffield and St Louis reveal the different dimensions of the consequences of planning decisions. In a city where CBD is not very strong, an urban rail system may not gain a very high patronage from serving the CBD; therefore, it would be beneficial for its patronage to serve other areas of commercial and retail agglomeration. On the other hand, providing access to such areas may result in further decline of the CBD. These multi-dimensional problems need to be addressed in the planning framework.

5.2.5.2 Stimulating development in declining areas

All eight of the systems serve economically depressed neighbourhoods or old and declining industrial areas; however, they had very limited revitalising impact on such areas. Vancouver SkyTrain is the only system that had significant and positive impact on this type of areas. The system uses existing right-of-way which was the alignment of an old freight railway; therefore, there were industrial areas along the system, some old and abandoned, some still in use. As described in Section 4.5.5 of Chapter 4, these areas were redeveloped by the municipalities which had jurisdiction over the area (Figure 5.12). Station sites were developed as commercial or retail centres while other land along the line was redeveloped as residential areas which included both new luxurious houses and cheaper ones. The latter type of housing were provided by the municipalities in order to contain some of the original residents of the areas. In some cases, industrial sites have also been contained and regenerated.

In none of the US cities, did the systems have impacts on declining areas along the route although the revitalisation of these areas was often one of the objectives, and justification for building some, such as St Louis MetroLink and the Northern line of Miami Metrorail. Failure in these cities, seem to be due to lack of supporting renewal projects. (There is a rehabilitation project in St Louis; however, it was in a very early stage of implementation in 1997 when the city was visited.)

In Manchester, declining industrial sites in the southern parts of the CBD were redeveloped as office and residential uses as a result of the works of the Central Manchester Development Corporation. The impact of this project has been positive on its surroundings as mentioned in the section about the city centre. However, there are

Figure 5.12 Light industrial sites in Vancouver (above): some of them have been redeveloped as residential areas (below)

many other declining areas served by the Metrolink, which remained derelict (Figure 5.13); therefore, the system is not regarded as successful in fulfilling this criteria.

In Newcastle too, the Metro was not sufficient to regenerate declining industrial areas or economically depressed neighbourhoods. The regeneration project of the Tyne and Wear Development Corporation, as mentioned in Chapter 4, had almost no interaction with the Metro.

In Sheffield, the first line runs through an area where a comprehensive regeneration project by the Sheffield Development Corporation (SDC) was implemented. The extent to which the Supertram contributed to the regeneration project is limited. The tram runs at the margin of the new developments, and access to them from the tram stops is very poor. The inconvenient location of the tram in the area and its poor integration with the regeneration project is a result of the poor policy co-ordination between the regenerating agency and the transport planning agency (Lawless, 1999). The area went through significant changes, but Supertram had a very limited input in the regeneration process, and consequently received limited benefits from it. Furthermore, declining areas along the system which were not in the jurisdiction of the SDC remained derelict (Figure 5.14).

5.2.5.3 Improving the pattern of urban growth

The most effective system in terms of shaping urban growth is SkyTrain. The corridor that SkyTrain runs through became the main corridor of urban development with a notably denser urban form after the opening of SkyTrain. SkyTrain, alone, is not responsible for all these changes: most of the new development took place as a result of the vigorous planning actions of the municipalities. Densities along the system were increased by the rezoning plans. Office and retail development at stations was encouraged by tax incentives and development bonuses, that is permission to build office buildings or apartments higher than that permitted elsewhere (Figure 5.15 and 5.16). Furthermore, development permission at other areas of the city, particularly those that the development trends were in favour of, was strictly restricted. Moreover, government buildings and headquarters of utilities were relocated at the SkyTrain stations (Figure 5.17). As a result, some of the SkyTrain stations became the "new town centres" as

Figure 5.13 Declining industrial areas that remained derelict in Manchester

Figure 5.14 A derelict site in Sheffield: adjacent to the Sheffield Development Corporation project area

Figure 5.15 Burnaby Metrotown station: one of the new town centres in Vancouver

Figure 5.16 New residential developments taking place around new town centres in Vancouver

Figure 5.17 A government office building relocated at a SkyTrain station in Vancouver

proposed in the regional plan. Growing employment along the route also attracted residential developers to the area.

In addition to Vancouver SkyTrain, San Diego Trolley had some effects in terms of improving the pattern of urban development. The South Line of the Trolley, which was the initial route, was already developed before the Trolley opened; therefore, the Trolley did not have developmental impact on this corridor. Along the East Line, on the other hand, there are some station sites where new residential development has taken place at a density higher than the average residential density in San Diego. These developments were initiated by the municipalities and the transit agency of San Diego by offering incentives to the developers when they locate close to the Trolley stops. Incentives, which have been described in detail in Section 4.5.3 of Chapter 4, helped to increase development densities at stations (Figure 5.18).

Development occurred and densities increased at many stations in San Diego when the policies described above were implemented; however, there are two stations at the end of the East Line, where no development took place. When the East Line was extended in 1995, the City of Santee negotiated with the Metropolitan Transit Development Board (MTDB) that if the Trolley was extended to their jurisdiction, they would develop the new stations of the Trolley as new town centres (Larwin, 1997b). MTDB extended the Trolley to Santee; however, the City did not invest in the area. The Trolley serves vacant land at these stations (Figure 5.19). To summarise, the Trolley alone was not effective in encouraging development; consequently, at areas where it proved to be an effective tool in shaping urban development, the main factors behind its success were the supporting policies of the municipalities.

In the other three American cities, where urban development is dominated by sprawl in very low density, urban rail systems had insignificant effects on development. In Miami, the only effect of the system was a slight increase in the development densities at three stations on the Southern Line (Figure 5.20). New development which was realised by joint development schemes was mostly retail since areas along the Southern Line were favoured by retail developers Joint development projects were also offered along the Northern line; however, they did not attract any developers since the areas that surround the Northern line are declining economically (Figure 5.21), and there are vandalism

Figure 5.18 La Mesa Housing Project on the Eastern Line of San Diego Trolley

Figure 5.19 The last two stations on the Eastern Line of San Diego Trolley: Weld Boulevard (above) and Santee Town Centre (below)

Figure 5.20 Datran Centre: a joint development project at the Dadeland South Station of Miami Metrorail

Figure 5.21 Northern Line of Miami Metrorail: joint development projects could not be realised

problems at station sites, as mentioned in Chapter 4. As a result, the overall impact of these developments have been negligible: it is not possible to claim that the Metrorail has become a factor in locational decisions of developers. Furthermore, the impact of these developments on the patronage of the Metro has also been limited since retail is not a very transit-friendly development.

In Sacramento, as in Miami, the urban rail investment did not effect urban development. There have been several policies and actions by the municipalities and the Council of Governments to support the investment; however, they proved to be ineffective. For example, transit oriented development (TOD) incentives, which were similar to those implemented in San Diego, were introduced to encourage denser developments along the light rail line. However, they have not been as effective as they were in San Diego. Developers in Sacramento did not find high density development opportunities appealing because there was no market for high density housing in Sacramento. In addition to TOD incentives, two government buildings were relocated at an out-of-town location served by the LRT. The policy, which had been effective in Vancouver in terms of attracting other developers to the area, did not have any impact in Sacramento (Figure 5.22). As a result, neither the existence of the LRT nor the supporting policies have been effective in managing the low density urban sprawl in Sacramento.

There has not been any developmental impact in St Louis either; however, it may still be too early to consider developmental effects of the MetroLink which opened in 1993. On the other hand, at almost all stations outside the city centre, where there may be a potential of development, surface car parks have been developed, and these may hinder development close to station (Figure 5.23).

The British systems too had very limited impact on urban development. In Newcastle upon Tyne, there is very little evidence that the Metro has influenced land use and property markets, as stated by the impact report prepared by Davoudi et al (1993). The report also suggested that the attractive development opportunities created through Enterprise Zone and Development Corporation policies were incompatible with the location of the Metro, and have promoted development away from it. It will be remembered from Chapter 4 that indeed these new developments were conflicting with

Figure 5.22 Two government office buildings relocated at a light rail stop in Sacramento: they failed to attract further investment and development

Figure 5.23 Surface car parks at light rail stations in St Louis

the Metro. In addition, the development policies of the Newcastle City was also observed not to be very supportive of the Metro.

Manchester Metrolink, as the monitoring study (Knowles, 1994) showed, did not have much impact on development densities, or on residential locations. It did, however, contribute to the favourable factors that made office and retail activities stay and grow stronger in the CBD. They have been discussed under the sections about new development in the city centre.

In Sheffield, the Lower Don Valley area developed significantly; however, the tram's contribution to this development has been very limited as mentioned before. In this area and elsewhere along the route, the analysis of planning applications and land-use changes (Haywood, 1998a) showed that there was little evidence of Supertram developmental impacts. It is important to remember, however, that Supertram is the youngest system, and it is not very realistic to expect significant changes in land-use resulting from the tram yet. Nevertheless, development signs so far do not suggest that the tram has been important in location decisions of new developments.

5.2.5.4 Overall performance of systems in land-use objectives

The performance of systems in terms of their positive effects on urban development and land-use are summarised in Table 5.7. The systems are given a tick for each of the following criteria: if they stimulated development in the city centre; if they contributed to the revitalisation of declining areas along the route; and if they improved the urban growth patterns. The table shows that Vancouver SkyTrain was the most successful system. San Diego Trolley has been effective too, while the systems in St Louis, Tyne and Wear, and Manchester have been effective only in reinforcing the city centres. Systems in Miami, Sacramento, and Sheffield, on the other hand, did not have any significant impacts.

There are two important issues about the land-use analysis. First, systems in St Louis, Manchester, and Sheffield are fairly new and their effects on development can not be expected to be as strong as the others. However, in these cities, the analysis has been based on impact studies that analyse the development signs so far, or the interviews with experts. Secondly, none of the systems that are identified to be successful, have attracted development on their own. Supporting land use policies, incentives for developers, city centre redevelopment programmes and regeneration projects were the major actors that initiated developmental changes along the systems.

Table 5.7 Performance of the systems in attaining land-use objectives

	To stimulate development in the city centre	To stimulate development in declining areas	To change the pattern of urban development	Overall success
Miami Metrorail				
St Louis MetroLink	✓			✓
San Diego Trolley	✓		✓	✓✓
Sacramento Light Rail				
Vancouver SkyTrain	✓	✓	✓	✓✓✓
Tyne and Wear Metro	✓			✓
Manchester Metrolink	✓			✓
Sheffield Supertram				

5.3 THE OVERALL PERFORMANCE OF THE SYSTEMS

The overall performance of the systems are analysed by adding up the number of criteria that each system satisfied throughout the analysis. The more criteria they satisfied, the more successful they are regarded as being.

In Table 5.8, the performance of the eight urban rail systems are shown against the five objectives. Vancouver SkyTrain is the most successful system, since it satisfied 10 criteria (out of 15). It performed well in all objectives, except the one about car traffic. St Louis MetroLink and San Diego Trolley perform as the next most successful systems: they fulfilled 8 criteria, and performed well in three objectives. Manchester Metrolink fulfilled 7 criteria and performed well in two objectives while Tyne and Wear Metro fulfilled 6 criteria and performed well in cost-effectiveness analysis. The least successful systems are Miami Metrorail with only 1 criteria fulfilled; Sheffield Supertram with 2 criteria, and Sacramento Light Rail with 3 criteria.

Table 5.8 The overall success of the systems

Systems in:	To attain high patronage	To operate cost-effectively	To increase public transport usage	To prevent/solve car traffic and associated environment problems	Land-use and development related objectives	Total number of ticks
Miami			✓			1
St Louis	✓✓✓	✓✓	✓✓		✓	8
San Diego	✓	✓✓✓	✓✓		✓✓	8
Sacramento		✓	✓✓			3
Vancouver	✓✓✓	✓✓	✓✓		✓✓✓	10
Tyne/Wear	✓	✓✓✓	✓		✓	6
Manchester	✓	✓✓✓	✓✓		✓	7
Sheffield			✓✓			2

In addition to the analysis of success against the above set of objectives, the performance of systems can be analysed by considering the extent to which they fulfilled their expectations. Each system was developed with a different set of objectives, which were listed in the previous chapter, in Table 4.7. These objectives can be combined with the above table, and the performance of the systems assessed against their own objectives, as shown in Table 5.9. Cells with open circles show objectives that the systems did not attain while cells with solid circles correspond to objectives they did attain. Systems were regarded as attaining an objective if they fulfilled two or three of the criteria. If they attained only one or none at all, they are regarded as unsuccessful in attaining the objective. This is a rather rigid method of determining the success of systems in attaining the objectives, and it is in fact very difficult to draw a line between systems that succeeded in attaining an objective and those that failed. Bearing in mind this caveat, the analysis shows that the systems in Miami, Sacramento, and Sheffield are unsuccessful since they have not attained the majority of their objectives. Tyne and Wear Metro, too, fulfilled only one of its objectives, that of stimulating development in the city centre. The systems in Vancouver and San Diego are regarded as successful since they attained most of their objectives: they failed in car-traffic related objectives. Manchester Metrolink attained three of its objectives. St Louis MetroLink, on the other hand, fulfilled the expectations regarding public transport usage, and the city centre, but failed to reduce growth in car use, to reduce traffic congestion, to revitalise declining areas, and to improve the pattern of urban development.

Table 5.9 The success of the systems in attaining their own objectives

Systems in:	To increase public transport usage	To operate cost-effectively	To reduce growth in car use	To relieve car traffic	To improve air quality	To stimulate development in the city centre	To stimulate development in declining areas	To improve the pattern of urban development
Miami	○	○	○	○	○		○	○
St Louis	●		○	○		●	○	○
San Diego	●	●	○	○		●		●
Sacramento	●		○	○	○		○	○
Vancouver	●			○			●	●
Tyne/Wear	○					●	○	
Manchester	●	●	○	○		●		○
Sheffield	●	○	○	○			○	

Key: ● indicates an objective that the system was developed for, and has been successful in attaining;
○ indicates an objective that the system was developed for, but could not attain.

Analysing the performance of systems in attaining their original objectives is useful in demonstrating whether the expectations were met. On the other hand, the objectives listed during the planning of systems may not be very realistic. First, they may be too optimistic. Second, the planners may have political motivations to include some objectives which the systems were not originally planned to attain. This may particularly be the case when receiving funds from Federal or Central Governments are necessary in order to proceed with the investment. Therefore, the first method of measuring success which provides a comparison of systems against a standard set of objectives will be adopted in this study. According to this, Vancouver SkyTrain is the most successful system, followed by the systems in St Louis, San Diego, Manchester and Tyne and Wear. The systems in Miami, Sacramento and Sheffield are not regarded as successful.

Some of the results support the findings of previous research on these systems. Indeed, Miami Metrorail has been referred to as an unsuccessful system in terms of its patronage (Kain, 1988; Pickrell, 1992; Walmsley and Perrett, 1992). On the other hand, the system illustrates that joint development schemes can be effective tools in developing station sites, as Miller et al (1989) argue. The success of St Louis MetroLink, and the reasons for its success, such as the radial urban form and location of stations, are also compatible with the findings of Warren (1995). The performance of San Diego Trolley, in terms of patronage, cost-effectiveness, and impacts on the CBD and urban growth are also compatible with the findings of Glick (1992) and Walmsley and Perrett (1992). For Sacramento light rail too, both Glick (1992) and Walmsley and Perrett (1992) observed attractive development incentives and urban planning policies for encouraging development along the line; on the other hand, the findings of this study have revealed that the effects of these policies were negligible. The policies have not been powerful enough to change the urban form which is strongly hostile to public transport. The findings that Sacramento LRT was not a very successful system in terms of its patronage and its effects on land-use support the argument of Johnston et al (1988). As for Vancouver SkyTrain, the findings of this study that its success was related to supporting regional policies and ambitious investment and zoning of the municipalities along the system support the evidence of Walmsley and Perrett (1992), TRB (1996a), and Mackett and Edwards (1998). Among the British systems, the patronage performance and city centre effects of Tyne and Wear Metro are compatible with the analysis of Walmsley and Perrett (1992). The findings that Manchester Metrolink was successful in cost-effectiveness and increasing public transport usage, but not so successful in terms of impacts on traffic and land-use support the findings of Mackett and Edwards (1998). Findings regarding the performance of Sheffield Supertram and the reasons behind its poor performance are also compatible with the argument of Fox (1996).

5.4 SUMMARY: REASONS FOR SUCCESS OR FAILURE

Throughout the performance analysis, possible reasons for the success or failure of the systems have been discussed. In this section, these reasons are summarised to provide a focus on what factors are important for the success of urban rail systems, based on the experiences of the case studies.

The success of Vancouver SkyTrain can to some extent be associated with urban form and socio-economic factors. Vancouver has higher development densities and higher public transport usage levels than the American cities, although not higher than the British ones. Therefore, in addition to the factors about the urban area, there must be other factors which influenced the success. The most important of these is the planning actions. During the construction of the system, municipalities have redeveloped old industrial areas that the system was located through, and channelled most of their investment to develop the corridor as a high a density residential area with retail and commercial centres located at the stations of the system. Local plans were adapted to the system; station areas were rezoned; development bonuses were offered to private developers; joint development schemes were implemented; and some government buildings were relocated at SkyTrain stations. The strong support of the municipalities can be partly explained by the planning background of the system. The SkyTrain was planned as the main instrument of realising the regional plan, and it was very well integrated with the existing local plans of the municipalities. In addition to the strong support of the municipalities, other factors, such as the high frequency of service, and the reorganisation of buses to feed into the system, seem to have contributed to the high patronage. During the initial years of operation, there have been problems too. The automatic technology, that is the system being driverless, caused concerns for the citizens. This was addressed by the opening of a segment of the system to the public earlier than the rest of the system, and offering free journeys on this segment. There were also some noise problems, which affected residential areas along the system. This problem was solved by the construction of noise barriers.

Among other successful systems, in neither St Louis, nor San Diego did the urban form seem to suit urban rail investment. St Louis had an advantage in that the city had historically developed along a radial corridor where the light rail system was located along. The radial corridor, therefore, enabled the system to penetrate many old activity centres in the central areas of the city. In addition, new developments located at the light rail stations, and conversion of some uses to retail centres in the city centre stations generated trips on the system. Integration of buses with the light rail system, which included a radical improvement of bus services, also contributed to the patronage on the system, and increased public transport usage in general. Moreover, operating policies, including free light rail journeys in the city centre at off-peak times, and employing additional security staff on board and at stations are also believed to have attracted passengers to the system. The latter policy also seems to have created an image for the MetroLink that it is safe compared to buses (Bi-State Development Agency, 1995). In spite of the overall success of the St Louis MetroLink, there have also been some negative factors which may have decreased the effectiveness of the system to some extent. Most of the stations outside the city centre accommodate a park and ride area. These parking areas are used almost to full capacity, therefore have helped the patronage of the system. However, they are surface car parks, and therefore hinder development at station sites. Another issue is that the central areas of the city are declining. There is currently a renewal project which is at the planning stage; however, it is believed that both the city and the LRT would have benefited more if the project had been introduced together with the LRT investment.

In San Diego, in spite of low density urban form and low levels of public transport usage, the light rail system has been successful. The location of the first line was an important reason for the system's success since the corridor had the highest level of public transport usage. In addition, the integration of the buses with light rail, the city centre redevelopment project with which the Trolley was planned in strong co-ordination, and the transit oriented development schemes of the municipalities, have been effective in increasing development densities and improving the urban environment along the system. On the other hand, not all the municipalities were eager to modify their planning policies to the Trolley. There are vacant and declining areas along the Trolley which did not receive any investment from the municipalities.

For Manchester Metrolink too, the location of the lines was an important factor. The system replaced commuter rail services which already had a substantial level of patronage. The light rail has been more successful than the former commuter lines, however. Providing a city centre rail link, and the service frequency seem to be among the reasons for the success of the light rail. Renewal of some city centre buildings, investments by the CMDC, and the pedestrianisation of a city centre street have also contributed to the success of the system. In addition, the urban form of the city was also suitable: Manchester is one of the highest density urban areas observed here, and it has radial urban corridors along which residential areas are concentrated. On the other hand, high fares and bus deregulation, which prevented the integration of the system with buses, may have limited the success of the system. In addition, support from the municipalities to invest at, and develop, the Metrolink stations were very limited.

Tyne and Wear Metro is observed not to be as successful as the systems in Vancouver, St Louis, San Diego and Manchester, but it is not unsuccessful either. The city has high population densities, and public transport usage is also substantially high. Besides, the system is very extensive, and serves the majority of town centres and a high proportion of residential settlements and employment centres in Newcastle upon Tyne. The city centre redevelopment project in the early 1980s is believed to have increased the effectiveness of the system, since redevelopment areas were well integrated with the metro stations. In addition, the system was very well integrated with buses when it opened for service. These factors must have contributed to the success of the system during its initial years of operation. However, the patronage has been declining recently. Loss of integration with buses since their deregulation outside London may be among the reasons for decreased patronage. In addition, recent investments, such as the Metro Shopping Centre built in an Enterprise Zone and the new office developments within the TWDC project, were not very supportive of the Metro. The existing development plans of the Newcastle City are not very supportive either.

Three systems have been observed to be unsuccessful: Miami Metrorail, Sacramento Light Rail, and Sheffield Supertram.

The main reason for failure in Miami was the unsuitable urban form and the low density of development. In addition, the CBD was very weak. It has been decentralising to other subcentres, and has lost its economic vitality to a great extent. Therefore, the CBD was hardly a trip generating or attracting centre for the system. As for the other subcentres, the system serves one of the new commercial centres, but there are many others in the city. It was also mentioned before that financial problems prevented the buses from being improved and service levels from being increased. Car restriction schemes were also planned but not introduced. Another problem in Miami was the public relations which were poorly handled, as described in Chapter 4. Citizens who opposed the investment, particularly its alignment, vandalised the system. In addition to these factors, the technology of the system may have hindered the success. The elevated metro required a high cost investment, and evidence has revealed that when the urban setting does not justify a high cost investment, the investment becomes very inefficient. The patronage of the system is poor; however, taking into account the high capital cost makes the system appear even less cost-effective. In addition, the city centre part of the Metrorail, the Metromover, is an automatic system, and operating trains without any metro staff on board is probably not very suitable for an urban area where crime and personal safety are important issues. In spite of all the factors that hindered the success of the system, joint development schemes contributed towards increasing the development densities in the corridor. Nevertheless, their effects remained negligible.

In Sacramento, the urban form was very unsuitable like in Miami, except that the CBD was very strong and economically vital, and this may have a positive impact on the system patronage. Among the reasons that hindered success, the high income profile of the citizens seems to be an important one. The development tradition and citizen values are strongly against transit oriented development. In Sacramento, high and even medium density housing is associated with overcrowding, low income, and to some extent with areas where there are urban crime issues. In spite of the efforts of planners to increase densities along the system by introducing development bonuses or tax incentives, private developers did not co-operate, because there was no market for high density housing in the city. The location of the routes also had some negative consequences on the performance of the system. A substantial part of the Northern line runs adjacent to a high capacity highway while the other side of the system is a forest reservation area. There are very few attractions along the line, which can generate or attract trips. In addition, financial problems had prevented the improvement of buses and their integration with the light rail system. The frequency of the trains also remained poor as a result of financial problems. In spite of the observation that Sacramento LRT has not been successful, there are some factors which have affected the system in a positive way. The pedestrianisation of a city centre street where the light rail system runs seems to have attracted and generated trips on the systems, and improved the urban environment. In addition, after the initial years of operation, buses were reorganised and integrated with the LRT, and free transfers were offered between buses and the LRT.

There are several factors which hindered success in Sheffield. The planners who were interviewed have argued that the system served low income neighbourhoods, which should not be the target population of light rail. In addition, the CBD was not economically vital, and therefore may have been a factor that affected patronage. There were also some design issues. Supertram is mostly street running, and it had rather poor signalling priority in traffic, which resulted in the system being slow and unreliable. This became a particularly important problem because there was competition from buses along the corridor. There were also some planning problems. The alignment of the system was designed to serve some high density council flats, which were demolished by the local authority during the construction of the system. One of the lines was planned to help revitalise a declining area which was the subject of a regeneration project led by an Urban Development Corporation. The co-ordination between the light rail project and the regeneration project was very weak: the line and the stops were poorly located for penetrating new activity centres developed by the regeneration project. On the other hand, the performance of the system has been improving recently. On-board ticket sales has been introduced by employing additional staff on each tram. This operating policy was introduced to address the problems related to the usage of ticket machines and the fare evasion; however, it is believed to have improved the image of the system as well, particularly in terms of personal safety. Signalling priority has also been improving.

Table 5.10 summarises the factors that made the systems successful, as well as the factors that hindered their success. It can be seen in the table that the case study analysis reveal some of the factors to be particularly important for the success of the systems. Among the external factors, urban form and socio-economic factors have been very important. Among the planning factors, public relations and the route location have affected the performance of the systems. Some design features, such as technology and segregation, also appear to be important. In addition, operating policies and supporting policies can be very effective in enhancing the success of systems. These factors and how they contributed to the success of the case systems are used in the next chapter, as the basis of the planning framework which is the main product of this research.

Table 5.10 Factors behind the success of the systems

	Factors that enhanced success	Factors that hindered success
Miami Metrorail	•Joint development projects	•Inconvenient urban form and low density •Lack of funds to improve buses and services •Failure in introducing car restriction schemes •Problems in public relations •Weak and declining CBD •Technology inconvenient for the urban area
St Louis MetroLink	•Radial corridor •Location of line and stations •Locating new developments at stations •Improvement and integration of bus services •Free journeys at the city centre at off-peak •Security staff on board and at stations •Providing car parks at station sites	•Declining CBD •Lack of a comprehensive redevelopment project for the CBD •Using most station areas for surface car parks
San Diego Trolley	•Location of the first line •Integration of buses with the system •City centre redevelopment project •Joint development projects •Transit oriented development schemes	•Weak integration of local plans with the Trolley in some municipalities

(cont.)	**Factors that enhanced success**	**Factors that hindered success**
Sacramento Light Rail	•Strong and economically vital CBD •Integration of buses with the system •Free transfers between buses and the system •Pedestrianisation of a city centre street	•Inconvenient urban form and low density •Very high income neighbourhoods that are very hostile to transit oriented development •Inconvenient location of routes •Lack of funds to improve buses •Poor service levels
Vancouver SkyTrain	•Medium-high density urban area •Substantial levels of public transport usage •High frequency of service •Integration of buses with the system •Planning the system as a part of the regional plan •Redevelopment of old industrial sites •Development bonuses •Joint development schemes •Relocating government buildings at stations •Early opening of a section for demonstration	•Problems with noise levels in initial years
Tyne and Wear Metro	•High density urban area with radial corridors •Substantial levels of public transport usage •Location of lines and their extensiveness •City centre redevelopment project •Integration with buses in initial years	•Lack of integration with buses •Poor co-ordination between the metro and the local plans and recent urban projects
Manchester Metrolink	•High density urban area with radial corridors •Substantial levels of public transport usage •High frequency •Location of lines •Renewal of some of the city centre buildings •Investments by the CMDC •Pedestrianisation of a city centre street	•Lack of integration with buses •Poor integration of local municipal plans with the LRT
Sheffield Supertram	•Medium density urban area with radial corridors •Substantial levels of public transport usage •Ticket sales on board by an additional staff	•Small and weak CBD •System serving low income neighbourhoods •Low segregation *and* low signalling priority •Lack of integration with buses •Demolition of high density residential areas •Poor co-ordination with the renewal project

6. DEVELOPMENT OF THE PLANNING FRAMEWORK

6.1 INTRODUCTION

This chapter describes the development of a planning framework which can help to enhance the success of urban rail systems. The planning framework can be used for predicting the success of a new urban rail system, and for providing recommendations on how to enhance its success. The framework is based on four sets of factors: external factors, planning factors, operating policies, and supporting policies; hence, the task of developing the framework is a qualitative one. On the other hand, the basis of the framework is the comparison of the experiences of different systems and comparison of the effects of different factors on the performance of systems; therefore, it is essential to adopt methods of quantifying the qualitative data to a certain extent. Throughout this chapter such methods are developed, particularly for the purpose of being able to represent numerically the positive factors that contributed to the success of systems, so that comparisons can be made and relations can be established between the number of positive factors and the level of success of systems. As a result, the methodology adopted integrates quantitative and qualitative techniques: quantitative techniques are used since they facilitate comparison, but the research retains its qualitative approach in the analysis of social, economic, and political aspects.

The development of the planning framework is based on the findings of the case study analysis. Four sets of factors were identified in Chapter 3, as those that are likely to affect the success of urban rail systems. The case study analysis carried out in the previous chapter revealed some of these factors to be particularly important while some others were observed to have fewer effects on the success of the systems. Table 6.1 provides a comparison between the factors identified in Chapter 3 and the factors observed to be effective in the case study analysis in Chapter 5.

Among the external factors, urban form, socio-economic factors, and the public transport operating regime, i.e. whether public transport operators are regulated or not, were observed to have effects on the success of urban rail systems. Among the planning factors, public relations were observed to be very important. The location of routes, that is the characteristics of the areas served by the systems, was also observed to be important while there was limited evidence that design features had an effect on success, except that some design features were unsuitable for some urban areas. Operating policies, transport planning and urban planning policies were all extremely influential on the success of the case studies.

Table 6.1 Results of the case study analysis: factors behind success

	All factors identified in Chapter 3 before the case study analysis	**Factors that the case study analysis revealed to be important**
External factors	Urban form Socio-economic factors Local government organisation Public transport operating regime Funding mechanisms	Urban form Socio-economic factors Public transport operating regime
Planning factors	Public relations Route location Design features	Public relations Route location Design features in relation to the urban area
Operating factors	Operating policies	Operating policies
Supporting policies	Transport planning policies Urban planning policies	Transport planning policies Urban planning policies

Local government organisation and funding mechanisms are not listed in Table 6.1 among the factors that were observed to affect success. In fact, co-ordination between local government bodies has been extremely influential on the policies introduced to support the systems. Therefore, local government indirectly affects the success of systems; however, the case study analysis did not reveal any type of local government organisation to be superior to others in terms of attaining and sustaining policy co-ordination. Planning agencies that by-passed municipalities and the lack of metropolitan governments were significant problems in the British cities; however, it is not possible to claim that the local government organisation in the US has been particularly advantageous for co-ordinating planning. When co-ordination between urban planning and transport planning was strong, it was not necessarily in an urban area where local government organisation appeared to be suitable for co-ordinated planning. For example, in Vancouver, there was exceptionally strong integration between the SkyTrain project and the local plans of the municipalities in a period when the metropolitan government was temporarily abolished, and the regional plan which integrated the transport and urban plans had lost its legitimacy. In San Diego too, the integration of local plans with the Trolley was very strong in one municipal area whereas other municipalities were not always supportive of the Trolley. The case studies showed that the effects of co-ordination between planning agencies can be best observed in terms of the policies. As a result, the focus of the framework will be on the policies rather than the local government organisation.

Funding mechanisms were not observed to be very influential on success either. For all urban rail systems, building and operating the systems cost-effectively were important objectives regardless of the source of funding. In addition, building the systems within budget was important for all systems. Exceeding the budget had negative impacts on service levels of both Federally or Centrally funded systems (e.g. Miami Metrorail) and locally funded ones (e.g. Sacramento Light Rail). Such effects are observed best in terms of the operating characteristics of systems. In addition to the funding of the capital cost, it is important whether the operation is subsidised or not. The British cases revealed that when the systems were not subsidised there was stronger emphasis on profitability, and this affected the operating policies. As a result, the focus will be on operating policies rather than the funding mechanisms: the consequences of funding issues will be addressed through the analysis of operating policies.

To summarise, the planning framework is designed to focus on the urban form, socio-economic factors, and public transport operating regimes among the external factors; public relations, route selection and some of the design features among the planning factors; and all policies covering operating, transport planning and urban planning. In the rest of the chapter, a methodology is developed for incorporating the external factors, planning factors, and operating and supporting policies into the planning framework. The chapter concludes with a discussion on what the application areas of the framework are, and how it can be used as a guide for enhancing the success of urban rail systems.

6.2 EXTERNAL FACTORS

6.2.1 Urban form

The case studies have revealed that the urban form of cities can influence the success of urban rail systems. It was observed that the economic vitality of central business districts (CBDs), the location of employment and retail outlets, the population and residential density, and the dominant urban pattern were particularly important.

Case study analysis has shown that an economically vital CBD which is the main centre for both retail and employment can contribute to the success of urban rail systems. The systems in Vancouver, San Diego, and Manchester, three of the successful ones, all served strong CBDs that were important commercial centres in their regions. In addition to economic vitality, in Manchester and particularly Vancouver, the central areas were the major concentration of employment and retail, providing an important number of trips on the urban rail systems that serve the CBDs. In Sacramento too, the CBD was economically vital and the main centre for employment. Although the system in Sacramento was observed to be one of the least successful, its strong CBD is believed to have contributed to the patronage of the system to some extent. On the other hand, economically weak CBDs in Miami and Sheffield may be among the reasons why the urban rail systems in these cities have not been very successful. It can be concluded that having a strong CBD which is the main location for employment and retail activities is an important factor for urban rail investment.

In cities where the CBD is not the main employment and retail centre, having some other subcentres may still create a suitable environment for urban rail investment. That is because the system can be planned to serve such centres, and hence can still carry an important part of commuter and retail trips. In Newcastle for example, an important proportion of employment was located in the industries along the River Tyne, which generated a substantial number of commuter trips on the Metro. Similarly, in Sheffield, the economic vitality of the CBD was very much affected by the opening of an out-of-town shopping centre, the Meadowhall Shopping Centre, but the Supertram was planned to serve this retail centre, which generates a number of journeys on the tram. The impact of the shopping centre on the patronage of the tram has not been very strong because the accessibility provided by the tram has been very poor compared to other transport modes that serve the site. This is an issue to be covered under 'route location'.

It is concluded that if there is a strong commercial and retail centre outside the CBD, it would help the patronage of the system if it serves this area. On the other hand, remembering the planning decision in St Louis (see the discussion in Chapter 5, Section 5.2.5.1), it can also be argued that designing the system to serve such affluent areas may affect the CBD in a negative way. At this stage of the framework, it will be suggested that serving a new and affluent centre may help patronage, but that precautions should be taken in order to prevent the CBD from decline. Suggestions on this issue will be provided under urban planning policies.

In addition to the factors regarding the CBD, population density is an important factor for success. Indeed, in higher density areas, an urban rail line can serve a larger proportion of the population. It can be remembered from Table 4.2 of Chapter 4 that all American case studies had low population densities while the others, the three British cities and the Canadian one, had densities that were medium to high. For the latter cases, having higher residential densities were among the factors that made the urban area suitable for urban rail investment. As for the US cities, low levels of success in Sacramento and Miami are often attributed to their low residential density. Indeed, in Sacramento, it has not even been possible to encourage developers to build medium density housing. It is evident that Miami and Sacramento suffered from the disadvantages common to sun-belt American cities. On the other hand, residential densities in San Diego and St Louis are very low, but this did not hinder their success. The relatively high development density in Sheffield did not make this system successful either.

The dominant urban pattern can also affect the success of urban rail systems. Urban form that consists of radial corridors was observed to be a contributory factor to the success of systems. In cities that have developed along radial corridors, a large proportion of population and urban activities take place along such corridors; therefore, an urban rail system located along a radial corridor can serve many urban activities, hence can have a reasonably high patronage. This is evident from St Louis: the success of St Louis MetroLink is often associated with its good location, which is along a radial corridor (Warren, 1995). For Manchester, Newcastle upon Tyne, and Vancouver too, being located on radial corridors were among contributory factors for the success of the systems there. The importance of urban form is further verified by the unsuccessful systems: in Miami and Sacramento, urban form is based on a grid-iron street pattern without dominant corridors of urban activities. It is very difficult for public transport in these cities to serve urban activities that have sprawled over a large urban area.

In addition to the urban pattern, the dominant trend of residential growth as well as commercial and retail growth were originally anticipated to affect success. Rapid suburbanisation in low density, and decentralisation of retail activities and employment do not seem to be suitable factors for urban rail investment. On the other hand, for all the cities observed here, both those with successful urban rail systems and those with unsuccessful ones, suburbanisation, urban sprawl and decentralisation of the CBDs were the dominant patterns of growth. Therefore, it is concluded that urban growth trends are relatively unimportant.

These factors are incorporated into the planning framework in two stages. First, factors that appear to be suitable for urban rail investment are listed. Secondly, a method is developed to count the number of favourable and supportive factors, and assign values to the overall result which can reflect the total number of factors that are supportive of urban rail investment.

Table 6.2 provides a list of the factors related to the urban form. Factors that were observed to have affected the urban rail systems in a positive way are listed. Cities are given one tick for each favourable factor that existed as an external factor during the development of their urban rail systems. The more favourable factors there are, the more successful an urban rail system is likely to be. This is evident from Vancouver and Manchester, the two cities which fulfil most of the conditions listed, and which have two of the most successful urban rail systems analysed here. On the other hand, the observation also reveals that these factors are only contributory factors, and cannot determine success alone. There must be many other factors that affect the success of urban rail systems since in two of the cities where there were very few supporting external factors (St Louis and San Diego), urban rail investments have been very successful.

Table 6.2 Physical characteristics of the urban areas in the eight cities observed

	The CBD is economically vital	Location of employment and retail: mainly at the CBD	at other centres which the system serves	Population and residential density: medium to high	Urban pattern: radial corridors [1]	Total ticks (out of 4)
Miami						
St Louis					✓	✓
San Diego	✓	✓				✓✓
Sacramento	✓	✓				✓✓
Vancouver	✓	✓		✓	✓	✓✓✓✓
Tyne/Wear			✓	✓	✓	✓✓✓
Manchester	✓	✓		✓	✓	✓✓✓✓
Sheffield			✓	✓	✓	✓✓✓

(1) and the system located along one of these radial corridors

As the second stage of designing the planning framework, a method has been developed to incorporate the effects of these different factors in a value-system which counts the number of supporting factors for each urban rail system. Two figures are prepared to show the methodology. They correspond to the CBD and the Urban Form parts of the framework, and are presented in Figures 6.1 and 6.3 respectively.

Figure 6.1 refers to the issues regarding the economic vitality of the CBD, and the location of employment and retail activities. It can be seen that the figure is based on these two main factors. Based on the case study analysis, these two factors are believed to be equally important; therefore, they are treated as having the same weight. When the criteria are applied to a city, if both factors are suitable, the city gains two points. This means that there are two supporting factors for an urban rail system to be successful in this city. Hence, both the CBD must be economically vital and employment and retail activities must be located in the city centre or if they are not, the system must serve the out-of-town employment and retail centres. If only one of the factors is supportive, the city is assigned one point. If none of the two factors are supportive, that is all questions are answered negatively, no points are given, indicating that the factors regarding the CBD are not supportive of urban rail investment.

The CBD part of the framework is applied to the case studies in Figure 6.2. The figure shows what these conditions were like for the case studies. In San Diego, Sacramento,

Figure 6.1 The framework: the CBD - its vitality and the location of employment and retail activities

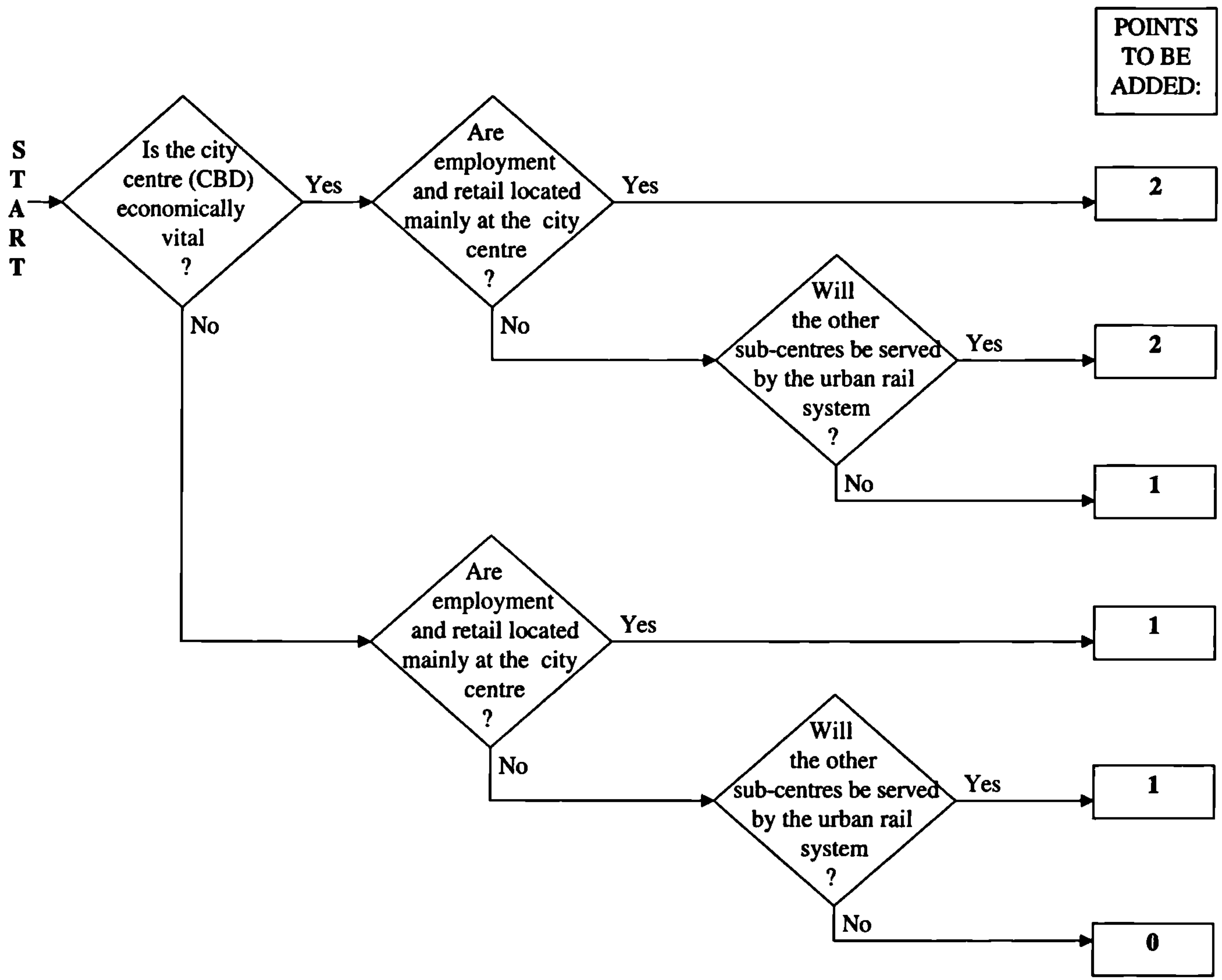
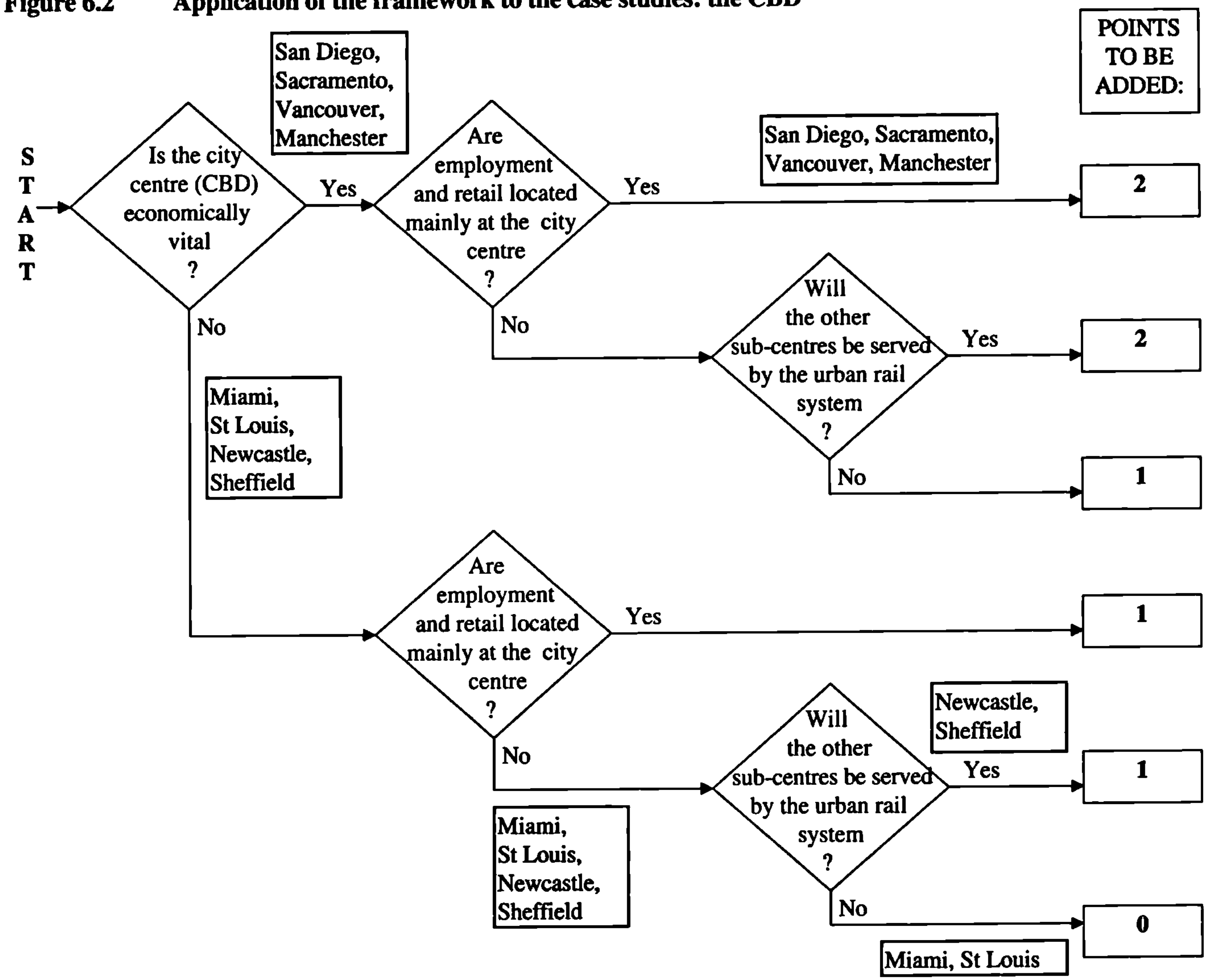


Figure 6.2 **Application of the framework to the case studies: the CBD**

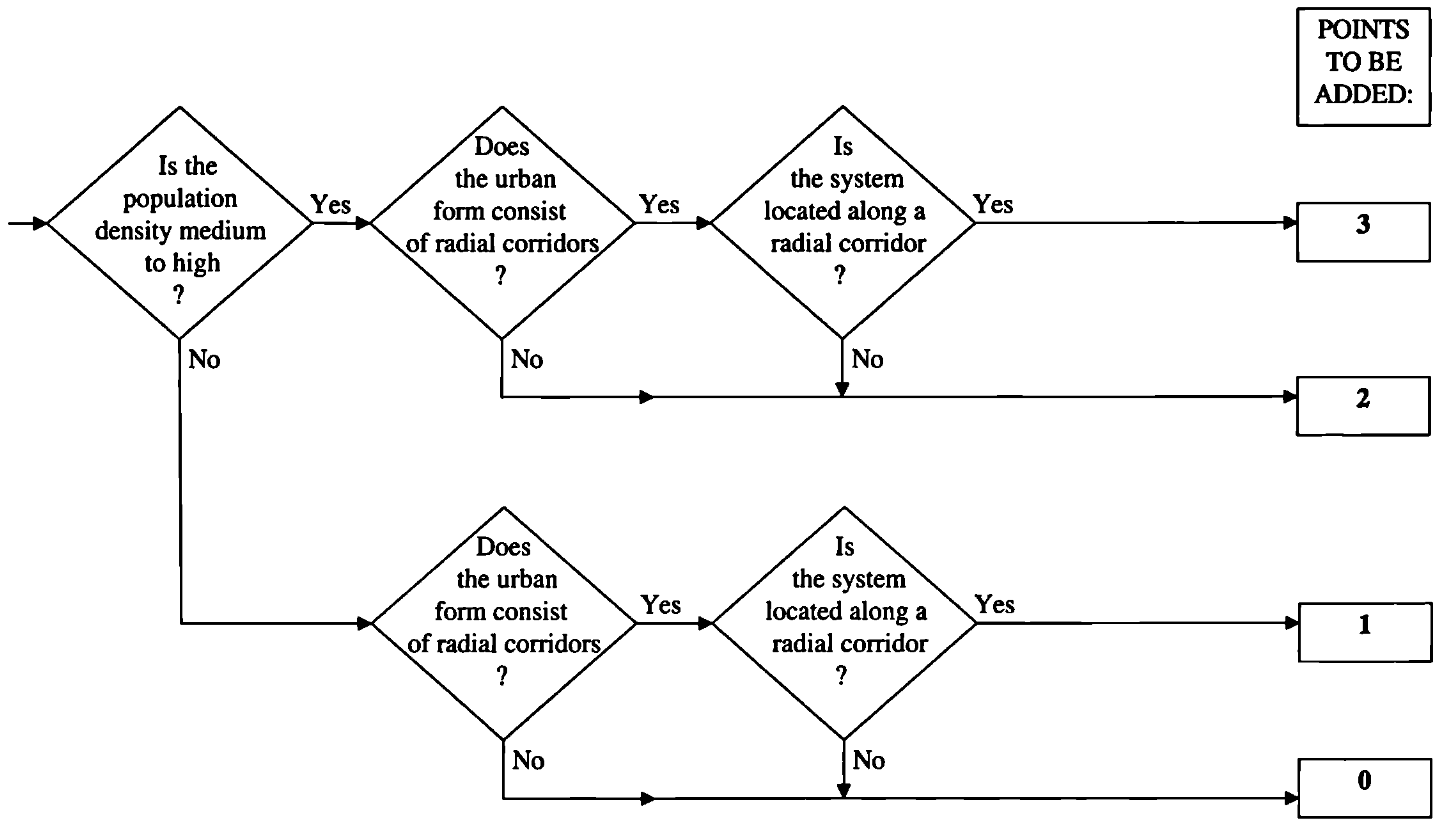


Vancouver, and Manchester, the CBDs are economically strong and the main location for employment and retail; therefore, they all gain 2 points. As for Miami, St Louis, Newcastle, and Sheffield, the central areas of the cities have suffered economic decline, and in all these cities there are other subcentres where the agglomeration of either the employment or the retail activity is threatening the vitality of the CBD. Among them, Tyne and Wear Metro and Sheffield Supertram serve such subcentres; therefore, these cities gain 1 point. Recently a new shopping centre, the Metro Centre, has opened in Newcastle, which is not along the Metro route; however, this is a recent investment, and is not considered among the settings for the metro investment. In Miami and St Louis too there are subcentres, particularly new office centres outside the CBD, but unlike Newcastle and Sheffield, the urban rail lines are not designed to serve these centres. As a result, the factors regarding their CBDs appear to be unsuitable for their urban rail systems to be successful, and they do not gain any points.

The Urban Form part of the framework is shown in Figure 6.3. It covers two factors: population and the development pattern. If the density of an urban area is medium or high, this is accepted to be a contributory factor to the success of urban rail systems. For the second factors to be accepted as contributory, two conditions must be met: the urban form must consist of radial corridors, *and* the system must be located along one of these corridors. It is believed that an urban area without any radial corridors is equally as unsuitable for an urban rail system to be successful as an urban area which has radial corridors but has its urban rail system located elsewhere. This is because, in both cases, the system will have the same difficulty in serving the population and developments.

The method of assigning values to the outcomes of the Urban Form is different from the method used for the CBD because the two factors are given different weights. Based on the case study analysis, it is believed that density is a more important factor compared to the existence of radial corridors. This is because, radial corridors are likely to affect patronage (as in St Louis), whereas density does not only affect patronage but also determines whether or not it is possible to influence urban growth patterns, or to increase development densities by the help of an urban rail system. In Sacramento, for example, where the residential densities are very low, it has not been possible to improve the pattern of urban development by encouraging high density along the rail corridor.

Figure 6.3 The framework: urban form in relation to the location of urban rail line



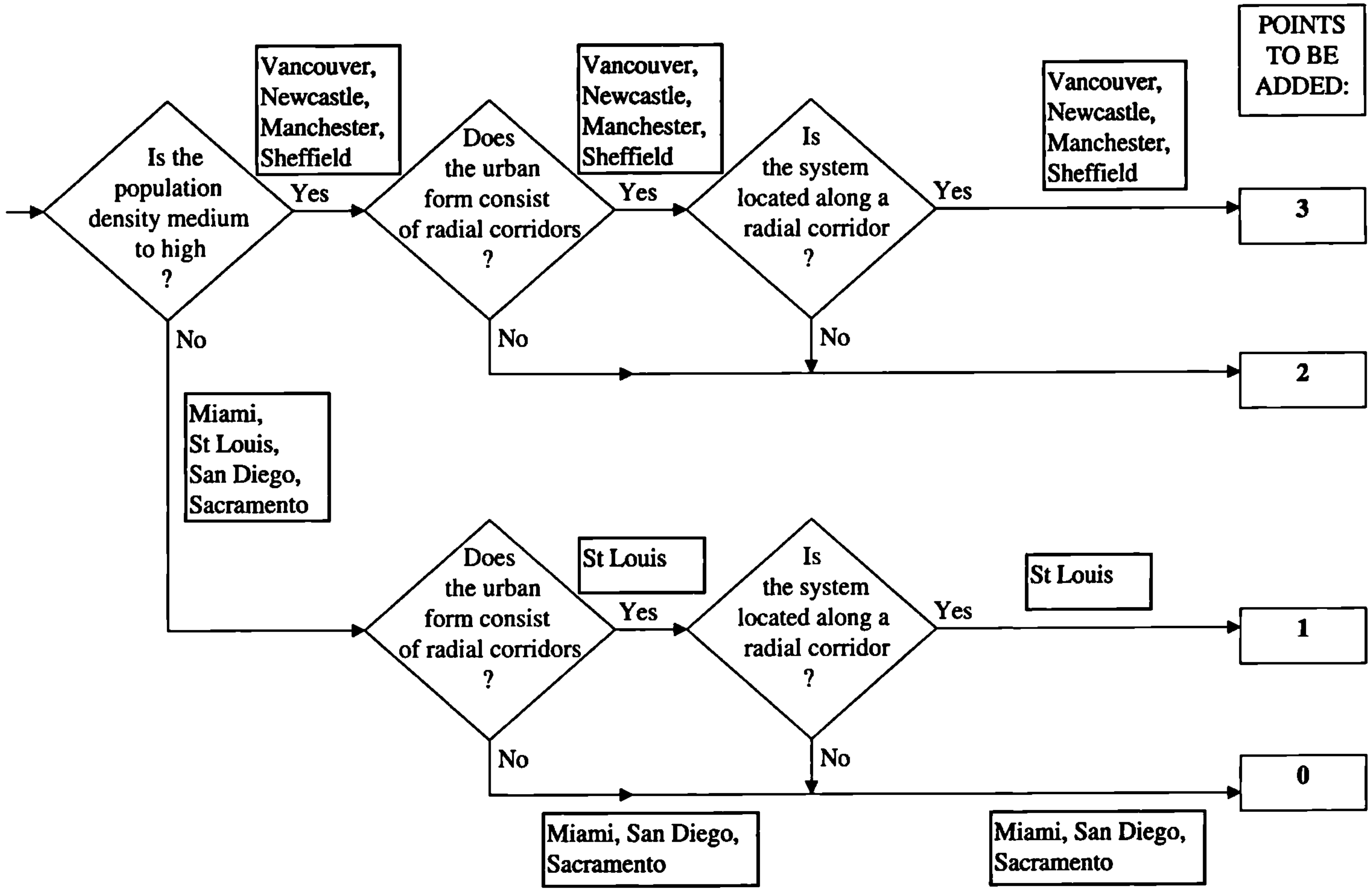
Sacramento has a very strong tradition of low density development, and there is a perception that high density housing areas are for low income groups and are not safe. Therefore, there is no market for high density houses. As a result the density factor is assigned 2 points, and the factor regarding radial corridors 1 point.

Figure 6.4 shows the application of the method to the case studies. Urban form in Vancouver, Manchester, Sheffield, and Newcastle upon Tyne was favourable to the success of urban rail systems. Population and residential densities were medium to high; the urban form consisted of radial corridors, and the urban rail lines were developed along these radial corridors. These cities gain 3 points since they fulfil two criteria, one of which is based on a weighted factor. On the other hand, Miami, Sacramento, and San Diego score the lowest, and do not gain any points. Their population and housing densities are very low, and their urban patterns are dominated by grid-iron street patterns without main radial corridors. St Louis, which is also a very low density urban area, is slightly better than the other cities because the city had developed along radial corridors, along one of which the MetroLink was located. Therefore, St Louis is assigned 1 point. Although it is low density like the other American cities, its radial corridor has enabled the light rail line to penetrate many activity centres in the city, and therefore contributed to the success of the system, as reported by other researchers, such as Warren (1995).

6.2.2 Socio-economic factors

Socio-economic factors have been observed to be very influential on the patronage of urban rail systems. Five factors were analysed under this category in Chapter 4: the economy of the cities, the economic vitality of the CBDs, car ownership, public transport usage and the income levels of the citizens. The economic vitality of the CBDs has been included in the planning framework in the previous section under the urban form regarding the CBD. Therefore, it will not be included in this section. The general economic trends of the cities will not be the focus of the framework either. It was observed that the local economy of the areas served by the systems was more important than the overall economy of the city. A city with growing economy does not necessarily indicate that investments can easily be channelled to a declining area. Therefore, this issue will be discussed further under the factors regarding the location of routes. Car ownership will not be included either. The case study analysis revealed that car

Figure 6.4 Application of the framework to the case studies: Urban Form



ownership levels were not as important as anticipated for the success of urban rail systems. There were successful systems in cities with very high car ownership levels, such as Vancouver, San Diego and St Louis, while there were unsuccessful systems in cities with lower levels of car ownership, such as Sheffield.

The case study analysis showed that it was necessary to consider an additional factor: the image of public transport systems in terms of personal safety. In addition, the local support for the urban rail project, which was analysed under public relations, is incorporated into the planning framework under socio-economic factors, since it appears appropriate to analyse this factors together with the usage of, and perceptions about, public transport.

Local support for the urban rail project refers to how the citizens respond to the investment. The reaction of the citizens to an urban rail system may be negative if they are against the investment for various reasons, such as the location of routes and stations, or the technology chosen. This may seriously affect the patronage of the system, as evident in Miami.

The general usage of public transport in the urban area can be a determinant of the patronage on the system, too. If public transport usage in an urban area is high, an urban rail investment can be expected to be successful. In Vancouver, Manchester, and Tyne and Wear, public transport usage which was high might have been a contributory factor in the success of these systems, while the low levels of public transport usage in Miami and Sacramento were among the unsuitable factors.

Some of the socio-economic factors need to be observed in relation to each other. In addition, analysis of some of these factors should focus on the urban rail corridor in particular, rather than the whole city. For example, public transport usage in the chosen urban rail corridor may be as important as the usage in the overall urban area. This is particularly important for urban rail systems that serve medium and high income corridors. It is often argued that light rail systems best suit higher income people; however, it may be very difficult to make people leave their cars and use the system if the whole tradition of urban growth and urban life is car-oriented, which was the case in

Sacramento. As a result, serving high income areas may not be very suitable, unless there already is a substantial level of public transport usage along the chosen corridor.

However low income may not be a very suitable factor for urban rail systems. Along a low income corridor, having a substantial level of public transport usage may not help the patronage of an urban rail system either. Low income households are often argued to be more likely to use buses; however, evidence from case studies reveal that the main issues of serving a low income corridor is associated with the operating environment and operating policies. In Sheffield for example, serving low income areas hindered the success of the system to a certain extent because there was competition from buses: bus fares and travelcards on buses were cheaper while there were no fare arrangements to encourage transfers between buses and the tram. A comparison with some parts of the San Diego Trolley, which carries low-paid Mexican workers between the Mexican border and industries at San Diego, reveals that low income citizens also use urban rail systems when there are supporting operating policies, such as free transfers and travelcards covering both buses and urban rail, making the urban rail system and the buses equally convenient to use. In Miami too, some parts of the line serve economically depressed neighbourhoods. The fact that in these areas buses were preferred to the metro may not be merely because of a negative reaction to the project, but also because the metro fares were higher than bus fares when the system first opened. In addition, transfer fares between buses and the metro may have discouraged users. As a result, serving a low income corridor may effect success negatively if the operating policies or the public transport operating regime in general are not supportive of the urban rail system.

Personal safety, as mentioned, is another issue that the case study analysis revealed to be effective on the success of systems. If personal safety is an issue for a system, citizens are not very likely to use it. This is a particularly important issue for American cities, where central areas are often declining and suffer from crime. Miami and St Louis are two examples, where urban crime is a severe problem, which also affects the level of personal safety on public transport modes. For Miami, this may be among the factors that hindered the success of the system. In St Louis, on the other hand, the low image of safety on public transport systems has been overcome by the provision of security staff on board, at stations, and at park and ride areas.

To summarise, public transport usage in the city, local support for the project, and the image of public transport systems in terms of personal safety were observed to be important factors. In addition, it was observed that the income levels of the people served were important, and that they should be evaluated in relation to other factors, such as the public transport patronage along the corridor where the system is located, and the convenience of bus operating regimes in terms of being able to control bus fares. How suitable these factors were for the eight case studies are shown in Table 6.3. The table is a summary of the above discussions. One issue that is not included here is the fare policies in Miami, which to some extent hindered the success of the system there. This issue will be addressed in Section 4.6, which analyses the operating policies. In this section, the income of the area in relation to the transport regulatory regimes is regarded as being suitable for Miami because fare problems did not result from the bus industry, as they did in Sheffield.

Table 6.3 shows that the socio-economic factors were very suitable for Manchester Metrolink. In San Diego, Vancouver, Newcastle, and Sheffield too, these factors were suitable while in Miami, St Louis, and Sacramento, they were not.

Table 6.3 Socio-economic factors in the eight cities observed

	Project has high local support	Public transport is considered safe	Public transport usage is high	Factors regarding income: system does not serve low income areas ***and*** public transport usage in the corridor is high	system serves low income, ***and*** bus fares can be controlled	Total ticks (out of 4)
Miami					✓	✓
St Louis	✓					✓
San Diego	✓	✓		✓		✓✓✓
Sacramento	✓	✓				✓✓
Vancouver	✓	✓	✓			✓✓✓
Tyne/Wear	✓	✓	✓			✓✓✓
Manchester	✓	✓	✓	✓		✓✓✓✓
Sheffield	✓	✓	✓			✓✓✓

These arguments are incorporated in the framework in two parts: Public Transport and Income Levels. Figure 6.5 shows the criteria that covers the Public Transport part of the framework. The figure is based on three factors: public transport usage, public transport image, and local support for the urban rail project. All three factors are assigned the same weight. However, in cases where public transport usage is high, it was considered that including the question about the safety image was unnecessary because even if there are concerns about the safety of public transport modes, this does not seem to prevent people from using them. Therefore, high usage of public transport can be regarded as a weighted factor only in this condition: it is accepted that if public transport usage is high, systems must also be considered safe, and 2 points are assigned.

When the Public Transport part of the framework is applied to the case systems (Figure 6.6), all the British cities and Vancouver, the Canadian city, each gain 3 points, having all three factors favourable. San Diego and Sacramento gain 2 points since public transport usage is low, but it is considered safe and urban rail investments received high support from citizens. In St Louis, public transport systems are not considered safe, and their usage is very low, but the rail project is strongly supported; therefore, 1 point is assigned. Miami, on the other hand, gains no points as all three factors are unfavourable.

Other socio-economic factors are included in the framework under the heading Income Levels, as shown in Figure 6.7. The main focus of the figure is the economic profile of citizens that the urban rail systems will serve. The figure aims to identify whether the systems will serve high and medium income neighbourhoods, or low income ones. As mentioned earlier, case study analysis has revealed that both outcomes may have consequences that affect the success of urban rail systems; therefore, the second part of the figure tackles these consequences. If a system serves high and medium income areas (or a combination of all incomes), there may be a potential problem that the people served are car-dependent, and will not give up their cars to use the new system. Car ownership levels were not observed to be a factor that determined whether or not this would be the case. Therefore, it can only be suggested that if the corridor already has a reasonable level of public transport patronage, e.g. where the urban rail system replaces an existing and fairly well-used public transport system, then the factors are suitable for investment, evident from the cases of Manchester and San Diego. It is also important that the pre-existing public transport service ceases after the opening of the systems:

Figure 6.5 The framework: public transport, personal safety, and local support for the urban rail project

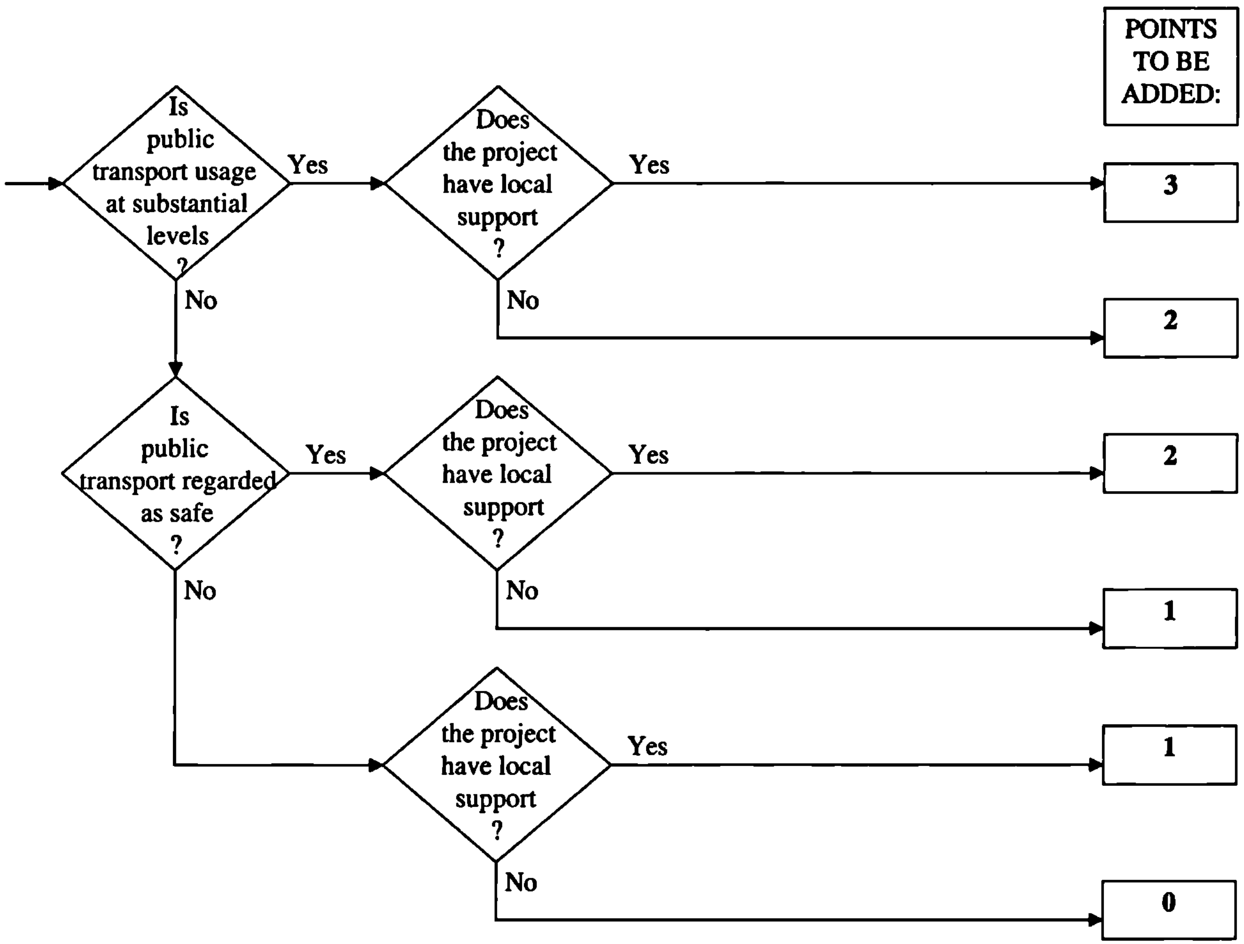


Figure 6.6 Application of the framework to the case studies: Public Transport

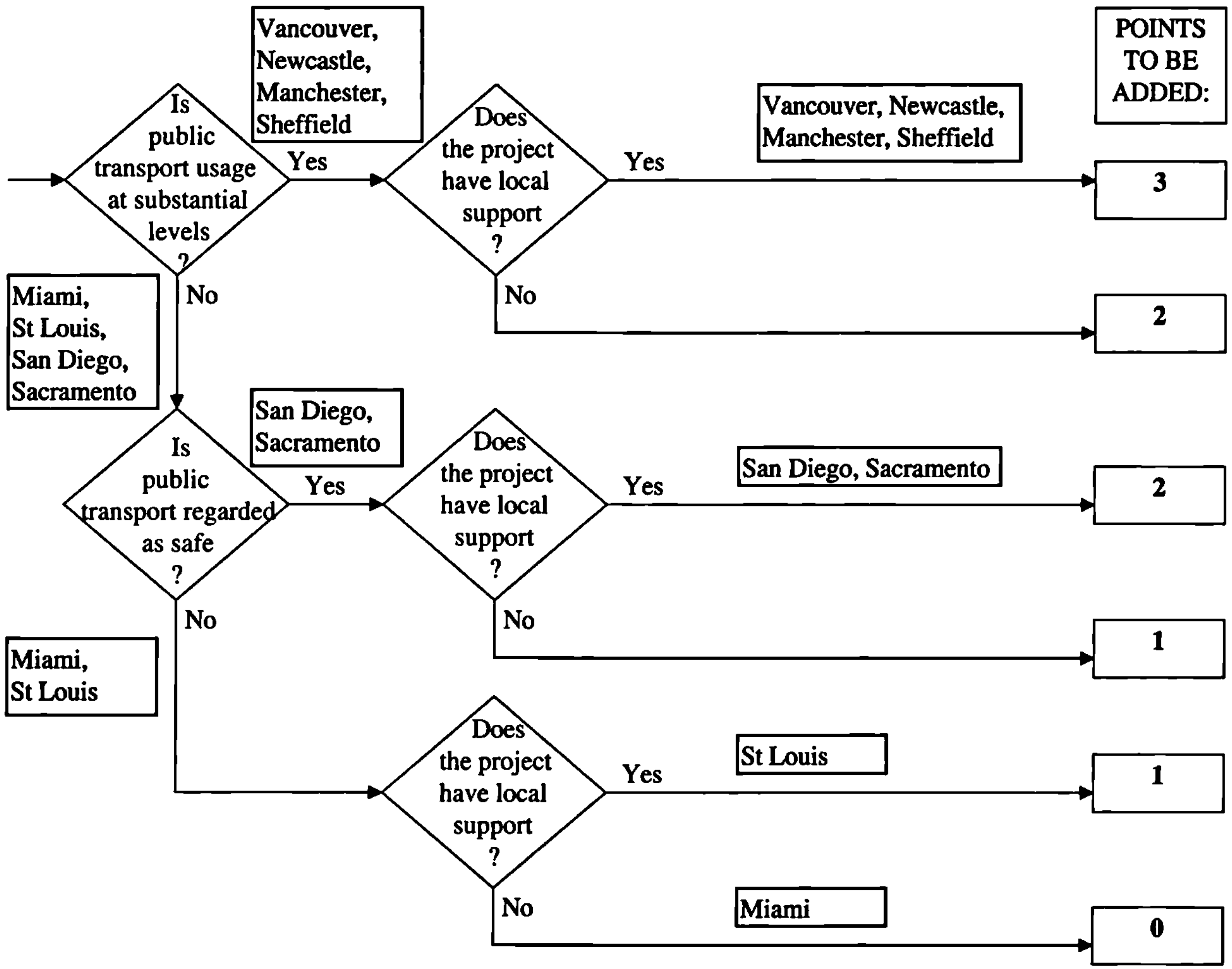
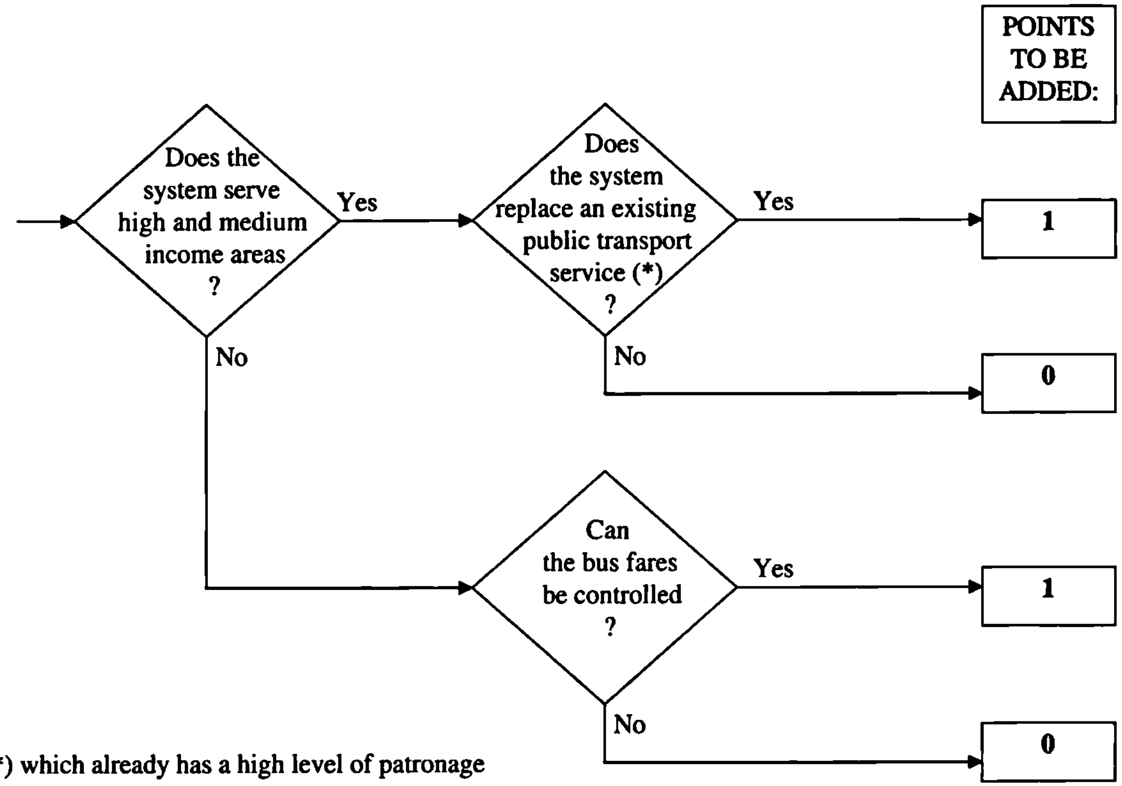


Figure 6.7 The framework: income levels - economic profile of the areas served



(*) which already has a high level of patronage

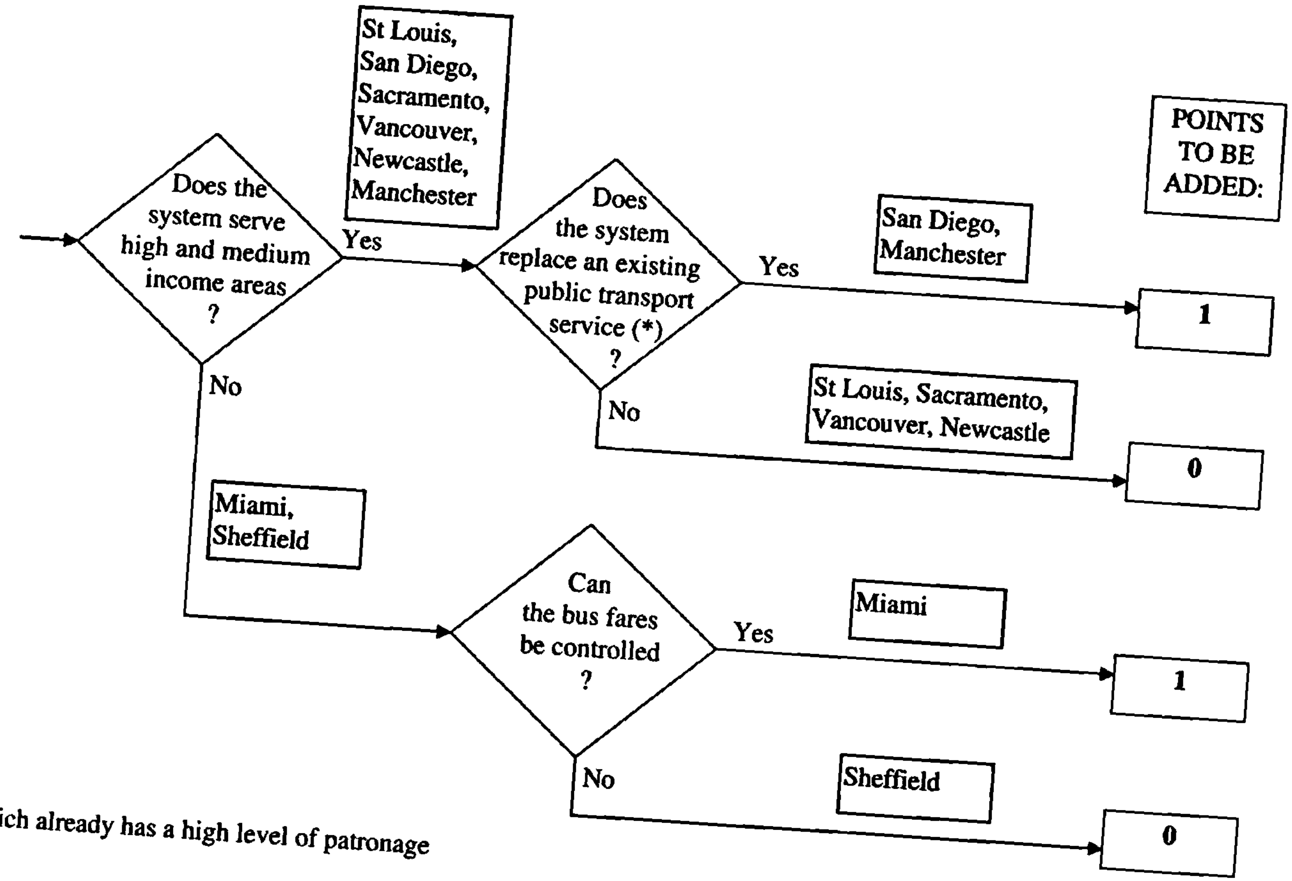
otherwise, the urban rail system would have to compete with this service. If the previous service is a bus service, this may not be a very unsuitable factor: it is often argued that medium and high income residents have a preference for rail-based systems. However, if the service which does not cease after the opening of the system is also rail-based, such as a commuter rail service, residents may continue to use this system, and the patronage on the new system may remain poor. As a result, it is a suitable factor if the new system replaces a well-used public transport service which ceases with opening of the new system.

If the system serves low income neighbourhoods, the state of the bus industry is very important. Public transport usage along a low income corridor can be expected to be high. On the other hand, it may be difficult to attract low income households to urban rail systems if bus fares cannot be controlled and there is competition from buses.

When points are assigned to the outcomes of the Income Levels, it is accepted that the possible consequences of serving low income areas are no less suitable than those of serving high income areas. The case studies did not reveal any significant difference: the consequences of serving low income areas in Miami and Sheffield were as negative as the consequences of serving high income areas in Sacramento. As a result, a system that serves low income areas where bus fares cannot be controlled is not assigned any points. A system that serves high income areas in a corridor where public transport usage is low is not assigned any points either.

When the criteria are applied to the case systems (Figure 6.8), those in Manchester and San Diego are given 1 point because they were located along a medium income corridor with existing public transport usage. The systems in Vancouver, Newcastle, St Louis, and Sacramento gain no points since they serve medium and high income corridors where the existing level of public transport usage was poor. Miami gains 1 point since it serves low income areas where bus fares can be controlled. The fact that they were not controlled and well integrated with the Metro is not addressed in this figure and will be discussed under Operating Policies. Sheffield does not gain any points since it serves low income areas for the majority of its routes and there is competition from buses.

Figure 6.8 **Application of the framework to the case studies: Income Levels**



(*) which already has a high level of patronage

6.2.3 The public transport operating regime

The most important issue regarding the operating regime is whether or not the urban rail system can be integrated with other public transport modes in the city. In all the North American cities observed here, public transport modes were well integrated with each other. This is because they were generally operated by a single agency, which was the same agency responsible for the development and operation of the urban rail system. There were also cases, such as San Diego and Vancouver, where the operation of different public transport services were carried out by different agencies, public or semi-private in some cases. However, in North America, public transport services are regulated; therefore, they are well integrated with each other, not only in terms of routes, but also in terms of fares. Integration of routes and fares was observed to be one of the most effective measures taken to increase the success of urban rail systems in North America.

In Britain, on the other hand, buses are deregulated outside London. Lack of integration between the urban rail systems and buses was an important disadvantage for the British systems observed here. Public transport systems did not support each other but competed with each other.

In addition to deregulation and the implications for service integration, private operation may have some disadvantages too. Since financial performance is the primary criteria for private operators, it may be difficult to introduce some of the fare-related policies that were used in the North American cities to support the systems. For example, offering free travel at the city centre at off-peak times of the day may not be an economically viable policy for private operators.

As a result, operating an urban rail system in a regulated environment of public transport operation, and public operation rather then private operation seem to be suitable factors for an urban rail system to be successful. The issues of deregulation was to some extent covered in the previous section (see Figure 6.7). Other consequences of the public transport operating regime will be observed in the operating policies as well as in some transport policies. As a result, the operating regime is not considered and counted as an individual factor here in the framework, but its possible effects on operating and transport policies are included in the relevant sections.

6.2.4 Demonstrating the framework on the case studies: External Factors

CBD, Urban Form, Public Transport, and Income Levels, which have been shown in Figures 6.1, 6.3, 6.5, and 6.7 respectively, aim to identify the implications of external factors for urban rail investment. When they are applied to the case studies, they give an indication of how appropriate the urban area was for urban rail investment. The scores that each system obtained from these sections of the framework are listed in Table 6.4. The last column shows the total points obtained by each system.

Table 6.4 Application of the framework to the case studies: External Factors

	Points gained from the framework: external factors				
	CBD (Figure 6.1)	**Urban Form (Figure 6.3)**	**Public Transport (Figure 6.5)**	**Income Levels (Figure 6.7)**	**Total points**
Miami	0	0	0	1	**1**
St Louis	0	1	1	0	**2**
San Diego	2	0	2	1	**5**
Sacramento	2	0	2	0	**4**
Vancouver	2	3	3	0	**8**
Tyne/Wear	1	3	3	0	**7**
Manchester	2	3	3	1	**9**
Sheffield	1	3	3	0	**7**
	out of 2	out of 3	out of 3	out of 1	out of 9

The table shows that Manchester was the most appropriate city for an urban rail system to be successful, followed by Vancouver, Newcastle upon Tyne, and Sheffield. The results also show that Miami and St Louis were the least appropriate urban areas for urban rail investment, followed by Sacramento and San Diego. Some of these outcomes can be verified by the results of the performance analysis carried out in Chapter 5. Indeed, the systems in Vancouver, Manchester, and Tyne and Wear were observed to be successful systems. Among the systems to which the framework assigned low points, those in Miami and Sacramento were indeed the least successful ones.

On the other hand, there are cities which suggest that it was not solely the urban setting that determined the success levels of these systems. St Louis, for example, scored only 2 points; however, the system there was observed as one of the most successful systems in Chapter 5. Another contradiction is Sheffield, which scored 7 points out of 9. Factors regarding its urban form and public transport usage were suitable for urban rail investment; however, the system was not observed to be very successful.

These outcomes have an important implication. External factors are important for the success of urban rail systems; however, they alone do not determine whether or not an urban rail system will be successful. They give a starting point as to what level of success can be expected from an urban rail operation in a particular urban area, but there are other factors that can make a system successful in an unsuitable urban setting, as well as factors that can make a system unsuccessful in suitable urban areas. These factors are addressed in the following sections.

6.3 PLANNING FACTORS

6.3.1 Public relations

Public relations are important for the success of urban rail systems. The problems experienced in Miami as a result of the negative reaction of some citizens to the Metro alignment have been described earlier. Public relations regarding the negative effects of the alignment of the system appear not to have been handled very well by the system planners. This problem is believed to be among the factors that caused the poor performance of the system. In addition to Miami, there was a period during the construction of the systems in Manchester and Sheffield when local businesses affected by the construction works reacted negatively. Such problems, however, were not very large scale, and did not affect the patronage of the systems.

The possible effects of a planning process where public relations are not well handled have been addressed within the socio-economic factors, under the heading 'local support for the project'. Therefore, public relations will not be analysed further in the framework.

It is believed that if public relations are handled successfully, the citizens' reaction to the urban rail system will be positive, and the local support high.

6.3.2 Route location

The case study analysis showed that the location of an urban rail system was among the most important factors in its success. Four factors can be listed regarding the location of routes: affordability; profitability; compatibility with urban growth trends; and compatibility with urban development plans.

Because of limited local resources, and the need to receive grants from Federal or Central Governments, affordability often becomes the most important criterion in choosing the corridors in which to locate urban rail systems. Many new systems, therefore, are located along existing rights-of-ways, which are often existing rail tracks, either abandoned old tracks or tracks still used by passenger or freight services. In the cases studied here too, corridors were often chosen on the affordability criterion. It will be remembered from Section 4.3.3 of Chapter 4 that in all the eight case studies, some parts of the lines were located along an existing track or existing right-of-way.

The most affordable route may not necessarily be the most suitable route in terms of attaining good patronage. That is because old railway tracks are usually surrounded by old industrial sites, which are not the best type of urban activity to provide good patronage on an urban rail system. The disadvantage of serving an industrial site has been experienced along the North-western part of MetroLink in St Louis, on some parts of San Diego Trolley, Sacramento LRT, Vancouver SkyTrain, Tyne and Wear Metro, Manchester Metrolink, and Sheffield Supertram. All of the above systems suffered the consequence of locating their urban rail system on a former rail route surrounded by declining industrial sites. Among them, only one, Vancouver SkyTrain, overcame the disadvantage with the help of the redevelopment plans of municipalities. In Sheffield too, the Lower Don Valley went through a massive regeneration project with several new leisure and office developments; however, this did not help the Supertram much since the two projects were very poorly integrated, and the location of the Supertram was not suitable to serve new developments, as described in Chapters 4 and 5. As a result, if the most affordable route is a corridor that serves declining industrial sites, it is important that these areas are redeveloped, and that the redevelopment is well integrated with the urban rail system.

Another factor regarding the location of an urban rail system is the profitability of its routes. This is a criterion important for the success of an urban rail system, particularly for the attainment of transport-related objectives. This criterion has been influential for the selection of the routes in Miami, San Diego, Manchester and Newcastle upon Tyne. In Miami, the Southern Line was expected to be a profitable option because it paralleled one of the busiest highway corridors in the city; however, the expectations were not met. In other cities, on the other hand, choosing the most profitable route helped the systems attain a high patronage. In San Diego for example, the Southern Line was not only the most affordable alignment, but also the corridor with the highest potential for generating a high patronage. In Manchester too, the initial lines were predicted to be profitable since they were taking over the rail commuter services along those corridors, which already had a substantial level of patronage. Route choice for the Tyne and Wear Metro was very explicit since the passenger railway tracks had to be improved. The metro decision emerged from this necessity; however, it was also important for decision makers that the existing tracks were conveniently located serving the main employment and residential areas of the city. In Vancouver too, although the corridor was that of a former rail line and hence contained declining industrial sites, there was also a history of residential development in the corridor, and the planners expected that this would help the success of the SkyTrain.

Evidence suggests that choosing a line that serves many activity centres and is well developed can help the system maximise its patronage. On the other hand, choosing a corridor which is already developed provides a limited opportunity for influencing urban development. Indeed, Manchester Metrolink and the Southern Line of San Diego Trolley had very limited impacts on urban development because areas they served were already developed. Therefore, if improving urban growth patterns and implementing transit oriented development schemes have priority over other objectives, an already developed corridor does not appear to be an appropriate choice. On the other hand, the experience of San Diego shows that land-use objectives can be attained more easily in later phases and extensions once the system has established itself as a successful, high patronage public transport system, because it then becomes an important factor for developers.

Another factor regarding the location of routes is the compatibility with urban growth trends. Locating the system along a corridor which is compatible with the direction of growth would be very effective because it would be easy to channel development along the line. Since these areas are already favoured by market forces, urban rail investment can become an important factor in development decisions, and the development of the areas along the line would in return result in high patronage of the system. The latest extension of the San Diego Trolley, the Mission Valley, is a good example. The natural direction of urban growth in San Diego is towards the north, and the Mission Valley extension is the first line of the Trolley that extends to the northern areas which market forces favour. During the construction of the line, several developments took place along it. Some of them were initiated by public agencies; however, private developers also found the corridor attractive to invest in, while the efforts of attracting developers to locate along other lines of the Trolley had not been as easy and successful, except in the city centre segments. The extension of the St Louis MetroLink towards the settlements at the eastern side of the Mississippi River may be expected to result in similar developmental impact since these areas are favoured for residential development.

The final factor that may affect success is the compatibility of the location of the system with urban plans. This criteria can help the systems to achieve high development impacts, which may be followed by high patronage. If the line serves areas that planners want to direct the city towards, then it would be likely that other investments and urban projects will be implemented along the line, and they may maximise the success of the urban rail system. Vancouver SkyTrain is a very good example. The corridor of the system was occupied by an abandoned railway. There was some residential development which could contribute to the patronage of the urban rail line; however, the main reason for choosing that corridor for urban rail investment was that the regional plan proposed the creation of new town centres along this corridor. To realise the 'regional town centres' project, municipalities channelled investment along the corridor, and redeveloped old industrial sites as residential areas. All these investments helped maximise the success of the Vancouver SkyTrain, and helped it overcome the disadvantage of being located along an existing rail track surrounded by declining industry.

The SkyTrain example suggests that the compatibility of the line with development plans can be a very effective factor. Indeed, as long as the municipalities remain committed to the plan, they may be willing to develop the urban rail corridors, and help realise the regional plan. However, this is not always the case. In San Diego, it was described earlier that the eastern line was extended to the Santee Town in order to support the development plans of the City of Santee; however, the municipality did not implement its plans. As a result, the stations are surrounded with vacant land. In addition, the eastern line of the Trolley was also compatible with the metropolitan plan that encouraged development in the eastern parts of the city as an alternative to the northern areas that development trends favour. However, the plan was not realised, and the corridor was not very well supported by the municipalities. Plans for redeveloping the city centre, on the other hand, were well supported. The City of San Diego invested intensely in the city centre, and the Trolley benefited significantly from the new developments that took place along its city centre segments.

Table 6.5. shows the four factors related to route location, and identifies how they can contribute to the success of urban rail systems. For profitability, the focus is on systems serving a well developed corridor or an under-developed corridor. This is because, the corridors being the most profitable in terms of public transport usage was already covered under socio-economic factors (see Figure 6.7). Here, location of the systems along a well-developed corridor is considered to be an appropriate factor while their being located along a vacant or an underdeveloped corridor is considered to be unsuitable for attaining reasonable patronage. For the affordability factor, the focus is on the possible consequence of choosing a corridor that contains former rail route: whether or not the areas served are industrial and declining. Hence, the factor will be accepted to be suitable only if it does not result in the system's serving declining areas. In fact, affordability may have consequences on the cost-effectiveness of the systems as well; however, the cost of alignment will be included in the framework in the next section, together with the cost of design features. Therefore, it will not be dealt under this section. Compatibility with growth trends and with urban development plans are also suitable factors since they can help the development of the corridor. For each urban rail system, corridors may have more than one of these conditions.

The table shows the factors regarding the locations of the systems. Most of them were located along well-developed corridors, except Sacramento LRT. However, all of them have suffered urban decline along their routes. None of them were compatible with urban growth trends, but most of them were supported by development plans, except those in Miami, Sacramento, and Sheffield. In Miami, it was stated that development plans' focus has been on enforcing the development boundary and that supporting the metro corridor has not been a priority (Kerr, 1997). In Sacramento, planners supported the system by implementing TOD projects; however, their plans proposed development mostly along the southern parts of the city where the LRT does not serve yet. In Sheffield, the southern line, that is the Mosborough Line, was compatible with the urban development strategies of Sheffield City Council which was encouraging the further development of the corridor. However, it demolished some high density residential houses along the route during the construction of the Supertram although the alignment of the system was designed to serve these residential areas. In addition, declining areas along the system were under redevelopment by a centrally appointed planning agency; however, the corridor of the Supertram was not in the jurisdiction of the redeveloping agency. As a result, it is difficult to suggest that urban plans and the tram project in Sheffield were compatible.

Table 6.5 Factors regarding the location of the routes of the case studies

Systems in:	The system is located along a developed corridor	The corridor does not serve declining areas	The corridor is compatible with growth trends	The corridor is compatible with urban plans	Total ticks (out of 4)
Miami	✓				✓
St Louis	✓			✓	✓✓
San Diego	✓			✓	✓✓
Sacramento					
Vancouver	✓			✓	✓✓
Tyne/Wear	✓			✓	✓✓
Manchester	✓			✓	✓✓
Sheffield	✓				✓

The table shows the total number of convenient factors regarding the location of systems; however, some of these factors need to be evaluated in relation to each other. For example, if a system is built along a developed corridor, this is regarded as a supporting factor since serving a well-developed area can make the system profitable. On the other hand, if the corridor is in decline, then its being well developed can no more be a supporting factor because developments that are declining are unlikely to generate many trips on the system. In addition, urban decline and growth trends should be considered in relation to each other. If there is urban decline along the corridor, there are not growth trends to support the corridor. Similarly, urban development plans should be considered in relation to growth trends. If the growth trends are favourable, it may not be important whether the urban development plans support the corridor or not. That is because development will occur anyway, and case studies have revealed market forces to be much stronger than urban plans in attracting developers.

These factors are incorporated into the planning framework as Route Location in Figure 6.9. Compatibility with growth trends is treated as a weighted factor and is assigned 2 points because it was observed to be more important than compatibility with urban plans, as discussed above. Other factors have equal weight and are assigned 1 point. There are only two issues about the way these factors are treated in the framework. Firstly, if there is urban decline along the corridor, it is considered that the corridor being well developed is no longer a contributory factor because development is suffering from economic decline. Secondly, when there is urban decline, it is accepted that growth trends cannot be favourable.

Figure 6.10 shows the case studies in terms of the suitability of their locations. The majority of the systems were located in corridors that were already developed, while Sacramento LRT ran through underdeveloped areas for significant parts of its route. The system serves areas that have declined and are economically depressed. Because the line was not compatible with the proposals of urban development plans, Sacramento scores 0.

All other systems were located at developed corridors which also served some declining urban areas. In Vancouver, the location of the line was compatible with redevelopment plans of the municipalities. In San Diego, most of the economically depressed areas were along the eastern line, which was a corridor encouraged for residential development in urban plans. In St Louis, the declining areas were subject to a regeneration study carried out by the Council of Governments. In Manchester, the Bury Line ran through some run-down areas, and revitalisation of these areas was an important planning policy. In Tyne

Figure 6.9 The framework: route location - characteristics of areas that are served

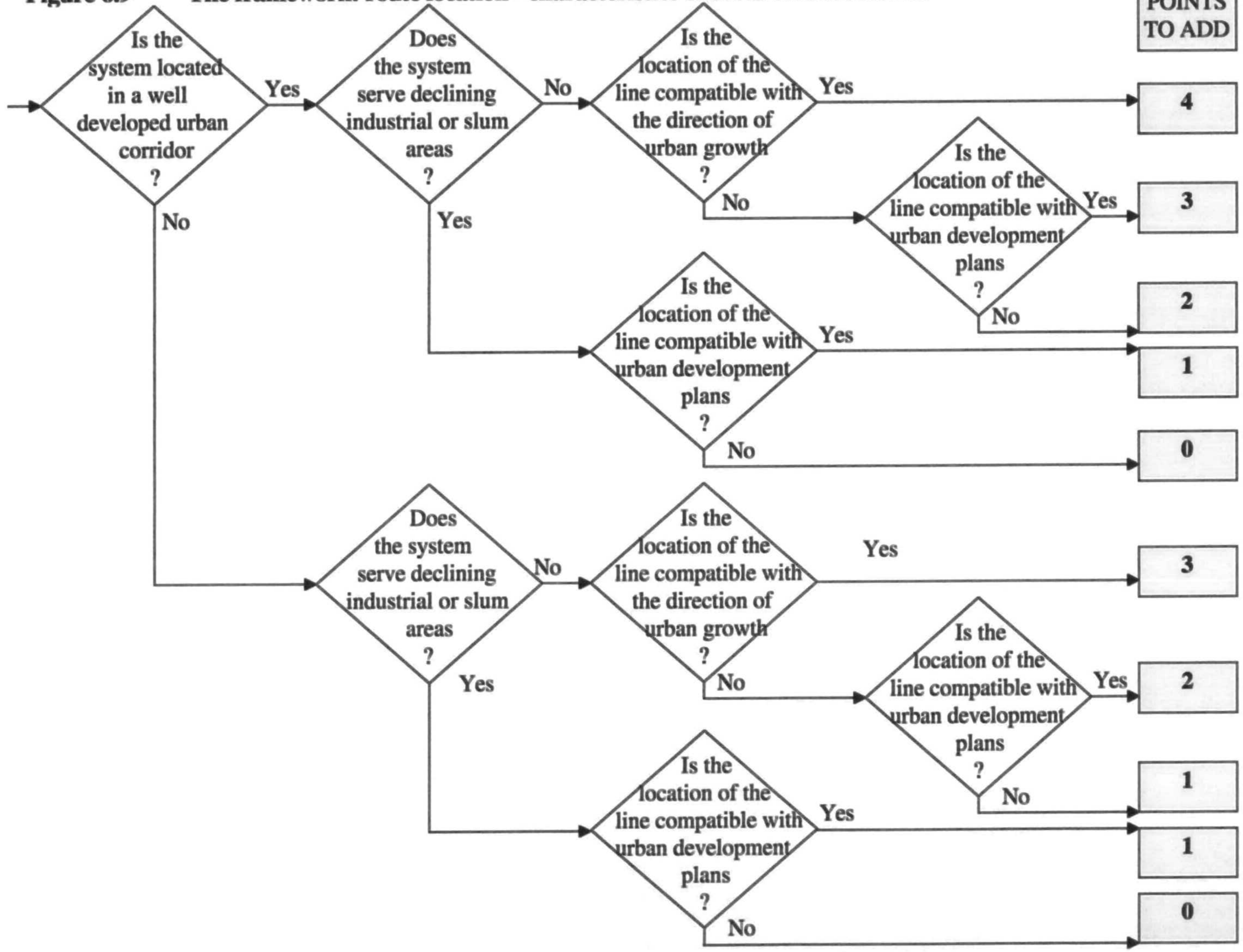
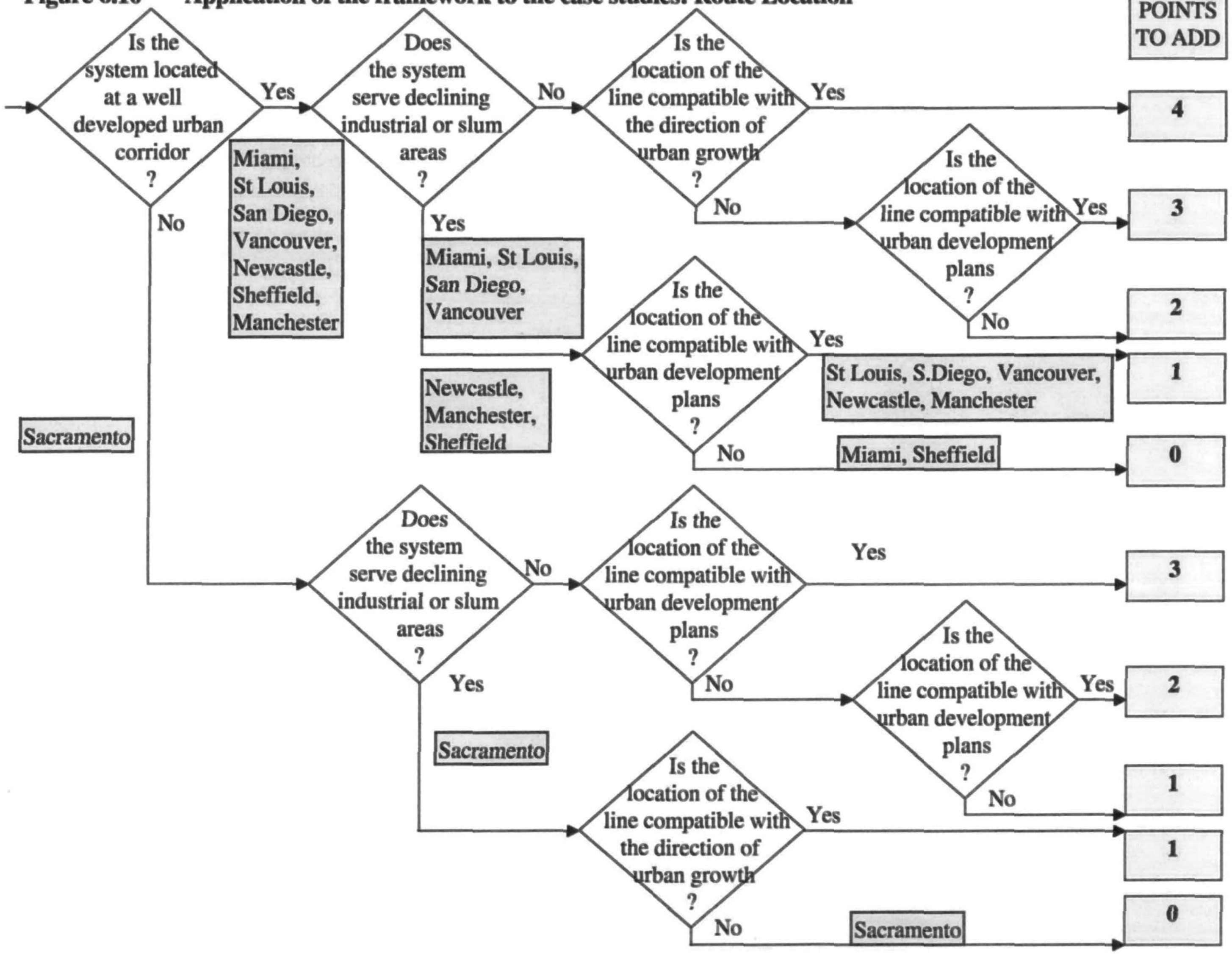


Figure 6.10 Application of the framework to the case studies: Route Location



and Wear, there were several declining areas along the lines, and improving such areas was included in the Tyne and Wear Plan. As a result, all these systems score 1, indicating that patronage may not be very good because of declining areas, but the corridors may be developed since they are supported by the urban plans. Whether or not they have been developed will be analysed under Supporting Policies, when the effects of urban planning policies are observed.

Miami Metrorail scores 0. It is located at a developed corridor which serves economically depressed neighbourhoods for almost half of its route. As mentioned above, developing the metro corridor has not been a priority of development plans in Miami. Some declining areas were announced as Enterprise Zones, but their interaction with the urban rail corridor has been very limited. There has not been a comprehensive plan, policy, or action aimed at regenerating these areas. As for Sheffield, it was mentioned earlier that urban plans, projects and actions were contradicting the tram project rather than supporting it. Hence, Sheffield also scores 0.

6.3.3 Design features

The design features of the case systems were analysed under six headings: technology, capacity, scale, level of segregation from traffic, type of grade separation, and spacing of stops. The observation of the case studies revealed that the design features had very limited effects on the success of systems. Although it was anticipated that certain design features may be more appropriate than others for the attainment of some objectives, there was little evidence suggesting a correlation between the design features and the attainment of objectives. Overall three observations can be made about the effects of design features.

The first observation concerns the technology. For Vancouver SkyTrain, the automatic technology enabled high frequency operation; however, this is observed under Operating Policies as 'service frequency'. Therefore, it will not be included here. The main observation regarding technology is about Miami Metrorail. It has been suggested earlier that the primary factors that hindered the success in Miami were related to the urban form and to some extent the political factors surrounding the construction of the system. However, it is possible to suggest that the choice of metro technology was also among the factors that hindered the success of the system: the high technology which required a high cost investment made the system appear even less successful in terms of cost-effectiveness. The patronage on the system was poor particularly when the amount of capital investment is taken into account. Sacramento was a similarly low density city which was an unsuitable urban area for rail investment, but because the cost of the system was extremely low, the system was not as inefficient economically as Miami Metrorail. One conclusion, therefore, is that investing in high technology high cost systems bears risks if the urban environment is not very suitable for urban rail investment.

The second observation relates to the design features in relation to personal safety issues. The technology of the Metromover in Miami, the system that serves the city centre, is automatic. Miami is a city where crime problems are at severe levels, and operating a public transport system without any operating staff on board does not provide a very positive image in terms of personal safety. In addition to automated technology, full segregation may not be a very suitable design choice in cities with crime and social security problems. Full segregation may not be among the main factors that impeded success in Miami, but it may have played a role in terms of decreasing the attraction of the system because public transport in the city is not considered to be very safe. On the other hand, problems regarding the safety can be overcome. Full segregation in St Louis did not cause any problems although safety was an important issue in the city: additional security staff on board and at stations improved the system's image of being safe.

Low levels of segregation, that is street-running systems, may cause some problems too. The third observation, therefore, concerns street-running systems. Sheffield Supertram has the highest proportion of street-running, and this feature of the system is believed to have impeded the success of the system to some extent, because it did not have a very high level of signalling priority over the cars. In addition to street running, the system had very high frequency of stops (see Table 4.8), which may have decreased its speed and reliability. These service qualities are very important in a city where buses are competing with the urban rail system.

In addition to the above observations, it may be suggested that the more extensive the systems are, the less successful they are in patronage indicators, as evident in San Diego and Newcastle upon Tyne. This is because initial routes are often located at the most profitable corridors, and extensions are often not as productive as the initial lines, as a result of which patronage per route kilometre as well as vehicle load levels fall. There is no evidence, however, that extensive systems are not successful in attaining other objectives.

As a result, design features may affect the success of systems, and three conclusions can be drawn. First, design attributes which increase the cost of the systems may hinder financial success if the urban area is not suitable for urban rail investment, as evident from the unsuitability of the high cost Miami Metro to the very low density urban environment. Second, full segregation and automatic technology may not be very appropriate choices if there are crime and safety related issues in an urban area. Finally, design features that may decrease the speed and reliability of systems may hinder success, particularly if there is competition from other forms of public transport.

Among the three observations, the consequences of the latter two can be addressed and overcome through operating policies; however, the first one is more difficult to tackle. That is because once high cost investment is made, the cost is sunk, and if the urban area is unsuitable, it is very difficult to overcome the cost-efficiency related problems. It is not only difficult, but it takes a long time to improve an urban area; therefore, a high cost investment needs to be justified by an appropriate urban setting. These arguments are included in the planning framework under Cost of Design, as shown in Figure 6.11. Cost of Design analyses the capital cost of systems in relation to the factors regarding their urban areas.

The capital cost per route kilometre covers most of the cost components, such as the cost of alignment, the cost of technology, and the cost of grade separation. Choosing a breaking point between expensive and inexpensive systems is a difficult task. It is not possible to suggest that if the technology is light rail, it would be cheap; there are many light rail systems as expensive as heavy rail ones. Therefore, in order to identify a breaking point between expensive and inexpensive systems, the average cost of new generation systems in the United States, Canada, United Kingdom, and Europe has been calculated. A list of these systems can be found in the Appendix.

Figure 6.11 The framework: cost of design features and their suitability to the urban area

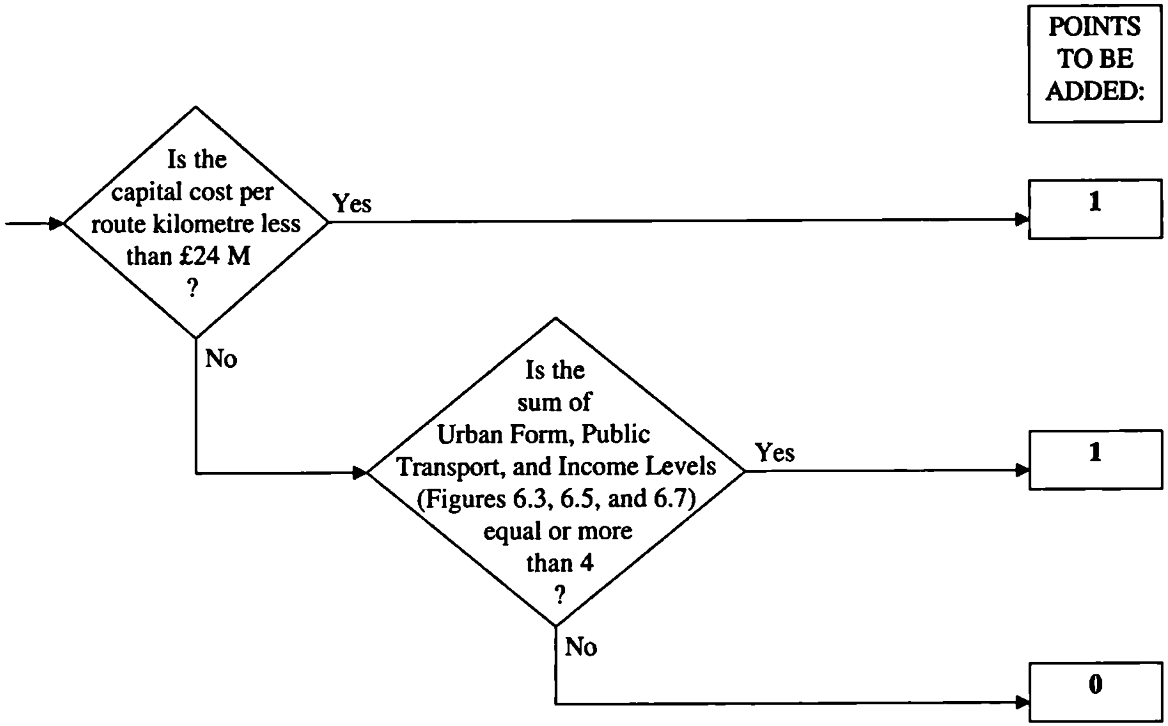


Figure 6.11 has three possible outcomes. The first outcome represents an inexpensive system, whose capital cost per kilometre of route is below the calculated average. This is a favourable outcome in terms of cost-effectiveness; therefore, it is assigned 1 point. If the cost of the system is higher than average, the system can still be expected to be cost-effective, provided that the urban area is suitable for urban rail investment. Therefore, if the sum of the outcomes of the Urban Form, Public Transport, and Income Levels (Figures 6.3, 6.5, and 6.7 respectively) is equal to, or more than, 4, the system scores 1, indicating that the factors regarding the urban area are suitable enough to justify the investment. If the sum of the outcomes is less than 4, on the other hand, the investment is likely to bear risks in terms of cost effectiveness. Hence, no points are assigned to this outcome.

When this part of the framework is applied to the case studies (Figure 6.12), all systems but Miami, score 1. Miami Metrorail is the most expensive system observed here, and the factors regarding the Miami urban area do not justify the high cost investment. Vancouver SkyTrain is similar to Miami Metrorail in cost; however, the urban area in Vancouver is more suitable; hence, the investment can be justified. All other systems were inexpensive, and score 1.

6.3.4 Demonstrating the framework on the case studies: Planning Factors

Table 6.6 summarises the scores that each system gained from the Planning Factors, and combines them with the total score of the External Factors. The external and planning factors of Manchester Metrolink and Vancouver SkyTrain were very suitable for urban rail investment. Therefore, it is concluded that these factors were among the main reasons for the success of these systems. It is important, on the other hand, to notice that external and planning factors in Tyne and Wear were almost as suitable as in Vancouver, but that Vancouver SkyTrain was much more successful than Tyne and Wear Metro. This seems to imply that operating and supporting policies, which will be discussed in the next sections, have enhanced the success of Vancouver SkyTrain. It can be argued that although Tyne and Wear Metro and Vancouver SkyTrain had equally suitable backgrounds, the former was not as successful as the latter because it was not supported well enough with policies. A similar argument can be made for Sheffield, where the external and planning factors appear to be suitable.

Figure 6.12 Application of the framework to the case studies: Cost of Design

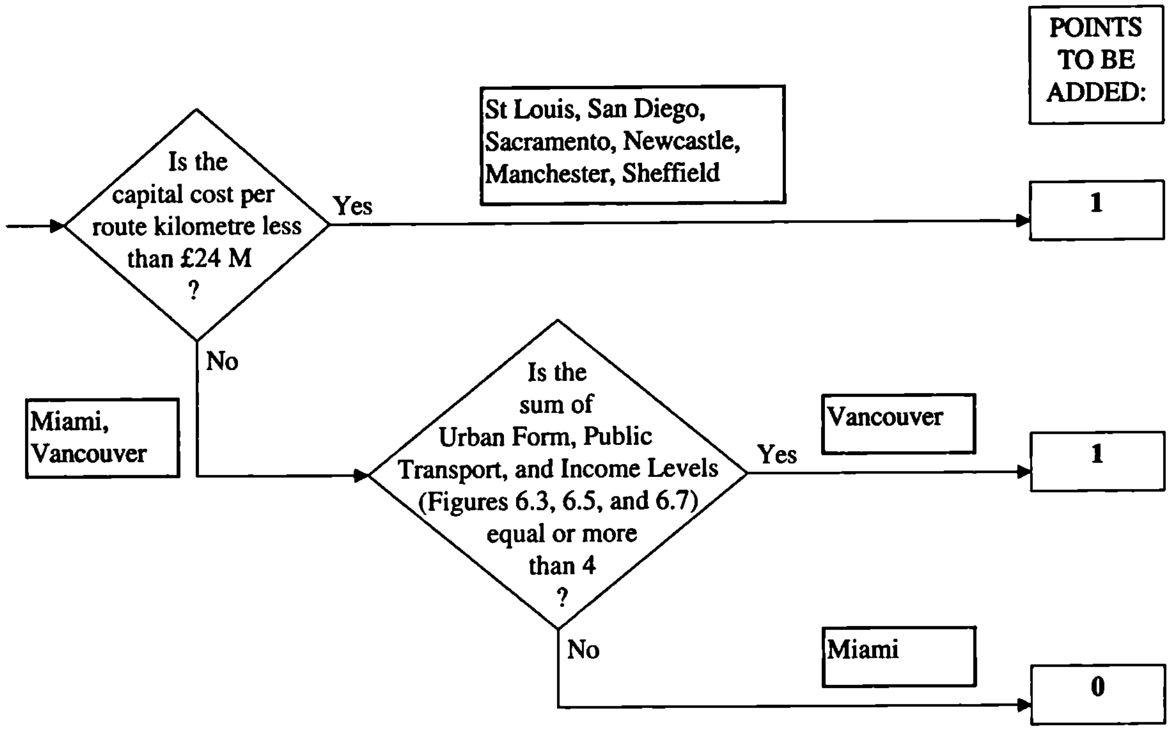


Table 6.6 Application of the framework to the case studies: External and Planning Factors

	Planning Factors		External Factors	Total of External and Planning factors
	Route Location (Figure 6.9)	Cost of Design (Figure 6.11)		
Miami	0	0	1	**1**
St Louis	1	1	2	**4**
San Diego	1	1	5	**7**
Sacramento	0	1	4	**5**
Vancouver	1	1	8	**10**
Newcastle upon Tyne	1	1	7	**9**
Manchester	1	1	9	**11**
Sheffield	0	1	7	**8**
	out of 4	out of 1	out of 9	out of 14

It is also remarkable that St Louis, one of the most successful systems, did not have a very suitable background. Indeed, the success of the system is very much associated with operating policies, as well as transport and urban planning policies.

6.4 OPERATING POLICIES

There are several policies regarding the way an urban rail system is operated which have been observed to affect the success of the systems. Based on the case study observations, six operating policies have been identified. These are listed in Table 6.7. More policies can be added to the list. This list is limited by the experience from the case studies. Policies that were not implemented in the cities observed are not included because their effects cannot be assessed. In addition to the policies listed, three other policies were observed but not included in the list: implementing zonal or flat fare systems; ticket enforcement methods; and scheduling of bus and rail services. The policy of implementing a zonal or a flat fare policy is not included because there was no clear evidence to suggest that any one of these fare systems is more effective than the other. Besides, it was considered that this was a decision that should be made with regard to the special features of an urban area, such as its size, population, and travel demands. Methods of ticket enforcement were not included either. There was no evidence to suggest any of the methods, such as ticket barriers and random inspections on board, are more effective than the others. On-board ticket sales were effective in preventing fare evasion in Sheffield, but it is an expensive method; therefore, its effects on cost-effectiveness were not significant. Having additional staff on board may have other effects however, and these are analysed under policies that may improve the personal safety image of the systems. Another policy that was considered but not included in the list is integrating the schedules of urban rail and bus services. Integrating buses and the urban rail systems in terms of route is treated as a transport policy here, and will be covered in the next section. When buses and urban rail systems have integrated routes, co-ordinated scheduling is a common outcome. Therefore, including the scheduling policy may lead to double-counting. As a result, six operating policies have been identified as shown in the table. One of them, marketing and advertising, was listed under 'supporting policies' in Chapter 4; however, it is included as an operating policy here because it is likely to be implemented by the operators of the systems.

Table 6.7 Effects of operating policies: evidence from the case studies

	Attaining a high patronage	Increasing public transport usage	Operating cost-effectively	Reducing growth in car usage	Improving air quality	Attaining land-use and development objectives
Providing frequent service	Vancouver Manchester	Vancouver Manchester				Vancouver Manchester
Introducing travelcards	(Miami) St Louis San Diego Sacramento Vancouver (Sheffield)	(Miami) St Louis San Diego Sacramento Vancouver (Sheffield)				
Offering free transfer to buses	San Diego Vancouver Sacramento	San Diego Vancouver Sacramento				
Offering free travel	St Louis	St Louis				St Louis
Marketing and advertising	St Louis San Diego Vancouver (Sacramento) (Sheffield)					
Providing security staff	St Louis Sheffield					

Notes: In Sheffield, by introducing additional staff for ticket sales on board, the personal security image of the system has been enhanced, and this has helped to increase the patronage.

The city names in boxes indicate that the policy was implemented in the city, and was observed to have had a positive effect on the performance of the urban rail system there, although some of these systems listed may not be successful in attaining the corresponding objectives (i.e. Sacramento, Sheffield). Names in parenthesis indicate that the policy has been implemented in the city, but failed to be effective.

The effects of policies on the attainment of objectives are also shown in the table, based on the experience of the case studies. It will be remembered from Table 4.9 in Chapter 4, that Vancouver SkyTrain is the most frequent urban rail service that is analysed here (2.5 minutes intervals). Experts interviewed in the operating agency stated that the high level of service supply which was enabled by the automatic technology of the system had been an important factor in attracting passengers to the system. There are, of course, several other factors contributing to the success of the system, as discussed before; however, when compared with other systems (for example, with the 15 minute interval of Sacramento Light Rail), it is apparent that the high service levels must have increased the attraction of the system. It may also have increased the attraction of new development areas along the line. In Manchester as well, the frequency of service at off-peak times of the day were much higher than that of the pre-existing rail service along the routes. Improved service frequency is believed to be one of the reasons why Manchester Metrolink had a much higher patronage compared to the patronage of the previous rail services (Knowles, 1996). It may also have contributed to the increased attraction of the city centre.

Integrating buses and urban rail systems is considered here as a policy that is initiated during the planning of the systems; therefore, it is considered to be a transport policy. Fare policies can maximise the positive effects of integration. Introducing travelcards which provide journeys on all public transport systems is one way of enhancing the integration of buses and urban rail systems. Travelcards were introduced in all North American cities, and it was anticipated that they have increased the attraction of both the urban rail systems and public transport in general. In Miami, this policy is not considered as effective because some citizens used only buses and avoided metro as a result of aforementioned political issues and the fact that bus fares were cheaper than rail fares in initial years. As for the British systems, the implementation of this policy has been very limited. Deregulation of buses makes it difficult to introduce such schemes. In Sheffield, travelcards valid for trams, and travelcards valid for all public transport systems were introduced, but they have not been very effective because passes that covered only buses were much cheaper. This is an example of the disadvantage of having unregulated competition between public transport modes. Fare integration could not be achieved in

Manchester and Newcastle either; however, there are current efforts to introduce travelcards in both cities.

Offering free transfers between different public transport systems can be a very effective tool for encouraging people to use public transport. Sacramento is the only case where free transfers without any conditions were offered to public transport users. Although the Sacramento LRT is not a very successful system, the free transfer policy is believed to have an effect on the steady increase of patronage on both the light rail and the buses. In San Diego and Vancouver, free transfers were allowed between modes within two hours of travel within the same zone and in the same direction. This might have an effect on the performance of these systems as well as on the overall public transport usage. In Miami and St Louis, transfers to and from buses are not free (Table 4.10). In British systems, free transfers are not allowed. Nor are there transfer fares. Buses and urban rail systems are operated by different agencies, mostly private, and there are no regulations to make them integrate their fares.

Offering free travel on the system is another operating policy which appears to be effective in increasing patronage. This policy was observed in only one of the case studies, St Louis. Between six stations in the city centre, journeys are free at off-peak times of the day. This policy was aimed particularly at citizens who never used public transport. Operators believe that the policy helped people overcome the threshold of using a public transport mode and using a new system. In addition, it had a positive effect on the retail activities of the city centre.

In addition to free travel offers, marketing and advertising the light rail system were among the effective actions taken in St Louis. Public informing and advertising were led particularly by the voluntary organisation, Citizens for Modern Transit. In San Diego too, marketing and advertising the system through public meetings, free rides and guided tours at new extensions has helped the system. In Vancouver too, there were marketing actions, one of which was the early opening of a section of the system for demonstrating the new technology to the citizens. Journeys on this section were free of charge until the rest of the system opened. In Sacramento too, free trips were offered during the initial days of operation; however, there was no evidence that it enhanced the attraction of the system. In Sheffield too, free trips were offered during the first days of operation as a means of advertising the system; however, operators stated that this caused chaos, and was not very effective in advertising the system.

Another policy regarding the enhancement of the image of systems is maintaining a high level of personal security. This is particularly important in cities where crime is a major social issue, such as in St Louis and Miami. In St Louis, precautions were taken: in addition to security cameras, safety officers have been provided on board, at stations, and at car parks. Customer surveys showed that passengers considered the light rail system to be safer than other forms of public transport (Bi-State Development Agency, 1995).

In Sheffield, on-board ticket sales have been introduced by employing additional staff on board. This policy was introduced to address a number of technical problems experienced at ticket machines at the tram stops; however, it also acted as an instrument of increasing the safety image of the system, and is believed to have had a positive impact on the patronage. The improvement may be related to the method of ticket purchasing as well as the improved safety image of having a conductor on every tram.

Operating policies are incorporated into the planning framework in Table 6.8. The table shows the experience of the case studies with each operating policy and the observations regarding the effectiveness of policies. It is seen that more policies were implemented effectively in Vancouver and St Louis than in other cities. Extensive use of operating policies in St Louis may partly explain why this system has been successful in spite of its unsuitable external and planning factors. Very few policies have been implemented in the British cities. There appear to be two main reasons for this. The first is that urban rail systems in Britain are expected to cover their operating costs fully. Local governments are discouraged from subsidising urban rail systems. In addition, except Tyne and Wear, these systems are operated by private companies who may not find it economically viable to implement some of these policies because they are likely to increase the operating cost. The second reason is the deregulation of buses outside London. It has not been possible to integrate the systems with buses, introduce travelcards, or offer free transfers between bus and urban rail systems, which were among the most common and most effective policies in the North American cases.

Table 6.8 The experience of the case studies with operating policies

	Providing frequent service	Introducing travelcards	Offering free transfer to buses	Offering free travel	Marketing and advertising	Providing security staff on board and at stations
Miami		⊗				
St Louis		●		●	●	●
San Diego		●	●		●	
Sacramento		●	●		O	
Vancouver	●	●	●		●	●
Tyne/Wear						
Manchester	●					
Sheffield		⊗			⊗	●

Note: In Sheffield, the security image of the system has been enhanced by introducing additional staff for ticket sale on board.

Key: ● The policy has been effective in enhancing the success of the system.
⊗ The policy has been implemented but failed to have significant effects.
O It is not certain whether the policy had any effect on the performance of the system.

In order to incorporate the operating policies into the planning framework, the total number of effective policies for each system is added to the sum of the points they gathered from the External and Planning Factors. Table 6.9 shows the results when the operating policies are included in the framework.

Table 6.9 Application of the framework to the case studies: External and Planning Factors and Operating Policies

	The sum of the outcomes of external and planning factors	Operating policies (policies that have been effective in enhancing the success of systems)	Total
Miami	1	0	**1**
St Louis	4	4	**8**
San Diego	7	3	**10**
Sacramento	5	2	**7**
Vancouver	10	5	**15**
Tyne and Wear	9	0	**9**
Manchester	11	1	**12**
Sheffield	8	1	**9**
	out of 14	out of 6	out of 20

It can be seen that as a result of the effective operating policies, the total points for St Louis have increased; however, it still has a low number of points bearing in mind that it is one of the most successful systems. Therefore, supporting policies must have had an important effect on its success.

6.5 POLICIES IMPLEMENTED TO SUPPORT THE SYSTEMS

Analysis of the case studies has revealed that policies that were implemented to support the urban rail systems were among the most effective factors in the success of the systems. Two sets of supporting policies have been identified: transport planning policies and urban planning policies. Examples are listed in Table 6.10 and 6.11 respectively. There may be other policies that can be added to the list; however, policies that have not been implemented by any of the case cities are not included. For example, among the transport planning policies, it is assumed that restricting car use and limiting car parking in the CBD may be an effective policy for increasing public transport usage. However, in none of the cities observed here, has this policy been implemented, and therefore it is not possible to analyse its effect.

Transport planning policies are policies that could be implemented by the transport planning agency at the planning stage of the system. Urban planning policies, on the other hand, contain policies, actions, and projects that are most likely to be implemented by municipalities, or metropolitan planning governments. These policies can take place during the planning and construction of systems, or after the opening of the systems. Both sets of policies are generally implemented to support and enhance the success of systems; however, some of these policies have been observed to have another function, which is enhancing policy co-ordination between transport and urban planning. For example, transport planning policies, such as integrating the system into regional plans and existing urban projects, are likely to make urban rail investment compatible with urban development plans and projects. As for urban planning policies, most of them are likely to improve the urban area and make it supportive of the new urban rail system.

Five transport planning policies have been identified: integrating the system into regional planning; integrating the system into existing urban projects; locating stations at trip attractors and generators; integrating bus services with the urban rail system; and providing car parks at stations. The effects of these policies on the attainment of objectives are shown, with the evidence from the case studies, in Table 6.10.

Table 6.10 Effects of transport planning policies: evidence from the case studies

	Attaining a high patronage	Increasing public transport usage	Operating cost-effectively	Reducing growth in car usage	Improving air quality	Attaining land-use and development objectives
Integrating system into regional planning	Vancouver (Tyne/Wear)					Vancouver (Tyne/Wear)
Integrating system into existing urban projects	San Diego Vancouver Tyne/Wear (St Louis)			(Tyne and Wear)		San Diego Vancouver Tyne/Wear (Sheffield)
Locating stations at trip attractors or generators	St Louis	St Louis	St Louis	(St Louis)		
Integrating bus services with new system	St Louis San Diego Sacramento Vancouver Tyne/Wear [1]	St Louis San Diego Sacramento Vancouver Tyne/Wear [1]				
Providing car parking at stations	Miami St Louis San Diego Sacramento (Tyne/Wear) (Manchester) (Sheffield)					

See note under Table 6.7

(1) The policy was implemented only during the initial years of operation, and aided the attainment of the corresponding objectives.

Integrating the urban rail system into a regional plan was observed to be a very effective transport policy. This policy seems to overlap with the compatibility of the line with development plans which was a factor covered under the Route Location. On the other hand, there may be other planning decisions in addition to the location of line, which may be shaped by the system's co-ordination with regional plans. Location of stations, technology, segregation, grade separation are such examples. As a result, integrating the urban rail system into regional plans will be considered as a separate contributing factor.

Vancouver appears to be the only city where the integration of the new urban rail system into the metropolitan development plans was the dominant factor. In Tyne and Wear too, the plan for the metro was initiated by a development plan; however, other factors, such as the need to upgrade an existing train service, have in time become more important in shaping the Metro project. It will be remembered that during the construction of the SkyTrain, the metropolitan government was eliminated, therefore the metropolitan plan lost its legitimacy. In spite of this, the municipalities remained committed to the plan. One reason for this commitment was that the regional plan and SkyTrain, which was based on this plan, were compatible with local plans and projects. GVRD, the regional planning government, incorporated the plans and projects of municipalities in its regional plan, and therefore provided a legitimacy for their implementation in integration with the SkyTrain investment. It can be claimed that if the SkyTrain plans were not compatible with the local development plans, the municipalities would not have been as vigorous as they were in redeveloping the industrial areas around the system, and in developing the station sites.

Therefore, in addition to integrating the system into regional plans, integrating it into individual urban projects is likely to result in high support from municipalities who carry out those projects. This was also evident in San Diego: the Trolley was very well integrated into the city centre redevelopment plan, and this provided continuous co-ordination between the municipality that carried out the redevelopment plan and the transit agency. Also, in Newcastle upon Tyne, the Metro stations were very well integrated with the city centre redevelopment and pedestrianisation projects. Integrating the system with these projects not only helped their realisation, but also increased patronage, since these improvements attracted and generated trips. Another consequence of the Metro and the pedestrianisation project in Newcastle was the reduction in the number of cars entering the city centre.

In St Louis too, the north-western parts of the line were justified by the fact that they served economically depressed areas which were under a renewal study by the metropolitan planning agency. Although it was too early to observe any impact, the renewal and regeneration project was being implemented.

Decisions regarding the location of lines and stations can also affect success. The location of lines were covered under Planning Factors, as the Route Location. Here, only the location of stations will be treated as a transport policy in order to avoid double-counting. In St Louis, almost all the MetroLink stations were very well integrated with trip attracting and generating activity centres. This helped the patronage of the system, and therefore may have indirectly affected the cost-effectiveness. There was evidence that locating stations at sports centres has increased public transport trips and reduced car trips to the stadiums during sports events.

One of the most effective transport policies is the integration of public transport modes. In all the North American cities, buses and urban rail systems were integrated with each other. Integration of modes involved reorganisation of bus services to feed into the new rail line, and in some cases, such as in St Louis, an overall improvement of the bus services. Transport operators who were interviewed for this study agreed that the integration of modes had considerable impact not only on the patronage of the urban rail system, but on overall public transport usage. The policy was not very successfully implemented in Miami: operators interviewed stated that financial problems had prevented the Metrorail from being integrated with buses as effectively as originally planned. As discussed before, buses and urban rail systems could not be integrated in the British cities as a result of the deregulation of buses in 1986. However, for Tyne and Wear Metro, which was opened in 1980, this policy was implemented until the deregulation, and had been very effective on its patronage. Although integration was later lost, it is believed that launching it as a fully integrated system provided a very good start for the Metro to be successful.

Providing car parking at stations outside the city centre was observed to be an effective policy for the American cities. The policy was implemented by the British systems too; however, it is not clear how effective the parking schemes have been for the success of the systems. The reason why their effects were clearer in the American cities may be because, compared to the British ones, these cities are very car-dependent, and attracting car users to the urban rail systems is a more important issue and a more difficult task. As for Vancouver, planners were against providing car parks at the station sites. It was believed that developing the corridor as an active high density urban area would yield more benefits than attracting car drivers to the system. Indeed, parking areas may be effective on patronage in the short term; however, if vacant land around the stations is used only for parking, which was the case in St Louis, they may impede urban development which would itself increase patronage in the long term.

Urban planning policies can be as effective as transport planning policies in increasing the patronage of systems. They not only help to increase the success of urban rail investment, but also help to transform the urban area into a public-transport friendly urban environment. It may be argued that if some of these policies are implemented, some land-use objectives would be attained even without the urban rail investment. This may be true to a certain extent; however, an urban rail system is a very effective instrument for realising the policies. In addition, creating a public transport friendly environment is the common goal of the land-use objectives, and an urban rail system can be a very effective tool for achieving this goal. Furthermore, there is often a symbiotic relationship: urban rail systems contribute to the attainment of land-use objectives, and the attainment of land-use objectives is likely to increase the patronage of urban rail systems.

Seven urban planning policies have been identified, as shown in Table 6.11: adapting municipal plans to the urban rail system; offering incentives for public transport friendly development (transit oriented development); implementing joint development projects; locating public developments at stations; pedestrianising city centre streets; implementing city centre redevelopment projects; and implementing urban renewal projects along the new urban rail system.

In St Louis, San Diego, and Vancouver some municipalities adapted their local development plans in accordance with the new urban rail systems. In St Louis and San Diego, although these actions had certain positive effects on the urban environment and on the systems, they were piecemeal actions, and not all municipalities produced plans supportive of the light rail systems. In Vancouver, on the other hand, co-ordination between urban plans and the rail system was much stronger and comprehensive. Municipalities directed most of the new development along the SkyTrain corridor, and this had a clear effect on the pattern and direction of urban development as well as on the improvement of declining areas along the corridor. As a result, the focusing of development along the system and the redevelopment of declining areas as residential increased the patronage of the system.

Another way of attracting development along the urban rail systems is through offering incentives to developers to invest along the systems. In all the North American cities, incentives, such as development bonuses, reduction in land prices, reduction in relevant taxes or fees, and relaxation of car parking requirements, were offered to developers in station vicinities. In Vancouver, St Louis, and San Diego, these incentives were successful in attracting new development at stations. In Miami and Sacramento, on the other hand, they failed to be effective. In Miami, reductions were offered in the capacity of car parking that was required for developments, but the policy did not appeal to developers, who considered parking capacity to be an important element of marketing their development, and therefore wanted to provide a large capacity of car parks. In Sacramento, development bonuses did not work as they did in San Diego because high density was unattractive. As described earlier, there was no market for high density housing in the city; therefore, developers did not find the development bonuses appealing.

Table 6.11 Effects of urban planning policies: evidence from the case studies

	Attaining a high patronage	Increasing public transport usage	Operating cost-effectively	Reducing growth in car usage	Improvin g air quality	Attaining land-use and development objectives
Adapting plans to the new system, i.e. rezoning	St Louis San Diego Vancouver					St Louis San Diego Vancouver
Offering incentives for transit oriented development	St Louis San Diego Vancouver (Miami) (Sacramento)					St Louis San Diego Vancouver (Miami) (Sacramento)
Implementing joint development projects	Miami Vancouver (San Diego)					Miami Vancouver (San Diego)
Locating public developments at stations	St Louis Vancouver (Miami) (Sacramento)					St Louis Vancouver (Miami) (Sacramento)
Pedestrianising streets	(San Diego) Sacramento Tyne/Wear Manchester					(San Diego) Sacramento Tyne/Wear Manchester
Implementing city centre redevelopment projects / actions	St Louis San Diego Tyne/Wear Manchester					St Louis San Diego Tyne/Wear Manchester
Implementing urban renewal projects	Vancouver (Sheffield)					Vancouver (Sheffield)

See the note under Table 6.7

Joint development projects too are aimed at attracting developers to the urban rail sites by offering land for free or below the market price. Few joint development projects took place in San Diego, but their effects on the urban environment and on the system were limited. In Vancouver, on the other hand, joint development projects at stations contributed to the development of the corridor, and eventually to the patronage. In addition to Vancouver, some joint development projects have been implemented in Miami. These projects failed to appeal to developers along the Northern line of Miami Metrorail, which serves an economically depressed area suffering from high rates of crime; however, they were effective in attracting developers to the Southern line, which is economically more affluent.

Another urban planning policy is locating at station areas public developments and public buildings, such as local government buildings, or utility headquarters, etc. This policy was implemented at some stations of the Vancouver SkyTrain, and contributed to the patronage of the system, as well as to the urban development taking place along the line. In St Louis, city centre stations were similarly used as focal points of new activities publicly developed. A convention centre and sports stadiums are such examples. In Miami and Sacramento too, government buildings were located at some stations; however, they had almost no effect in terms of improving the surrounding area or attracting further development at the station sites.

Pedestrianisation schemes in the city centres were observed to be effective for both the attraction of the urban rail system, and the enhancement of the city centre. In Manchester, Newcastle, and Sacramento, pedestrianisation schemes improved the image of the city centres, and increased retail activity. Urban rail lines serving pedestrianised centres benefited from these improvements, and carried passengers to the city centre on both peak and off-peak times of the day. In San Diego too, a city centre street was pedestrianised, but the effects were limited. The main street for business and retail was planned to be pedestrianised, but as a result of opposition from businesses, another street which was less central was pedestrianised. The effects might have been stronger if the initial plan had been implemented.

Implementing city centre redevelopment projects is a policy relevant only for cities where the city centre is declining. As mentioned earlier, in San Diego, the city centre redevelopment project contributed significantly to the success of the system. In Newcastle too, at the same time as the construction of the underground sections of the Metro, a renewal project was implemented in the city centre. In Manchester, since the bomb attack mentioned in Chapter 4, some city centre streets and buildings which were damaged have been redeveloped. None of the redevelopment activities were part of a comprehensive planning action for redeveloping the city centre; nor were they aimed at complementing the light rail investment in the city. However, they helped to improve the city centre, and increased the number of people visiting the city centre; therefore, the light rail system also benefited from the improvements. In St Louis too, there were piecemeal actions to enhance the urban environment in the city centre. Encouragement of development in the city centre has already been mentioned. In addition, some buildings at station sites were redeveloped as shopping and leisure centres. These actions were not part of a city centre redevelopment project; nevertheless, they enhanced the city centre and the station sites of the light rail system.

Implementing regeneration projects is also relevant only for cities with declining urban areas. All urban rail systems observed here serve economically depressed areas for parts of their routes. It is often anticipated that a new urban rail investment will help regenerate the economy of these areas; however, this is not the case: only when the investment is accompanied by urban renewal projects, can the area be revitalised. Without these projects, as was seen in Miami, San Diego, Sacramento, Manchester, and Newcastle, declining areas cannot be revitalised, and the urban rail investment in such areas becomes inefficient. Only in Vancouver, was a comprehensive planning action taken to redevelop old industrial areas that the SkyTrain runs through. In St Louis, there is an urban regeneration project which appears to be well integrated with the light rail system; however, the project was at a very early stage during the study visit to St Louis; therefore, the effects could not be observed. In Sheffield too, an urban regeneration project was implemented and improved the area. However, as described earlier, the two projects were poorly integrated, and hence did not derive much benefit from each other.

Transport and urban planning policies are included in the planning framework in the same way as the operating policies. Table 6.12 summarises the transport and urban planning policies, and shows the experience of the case studies with these policies. It is important to note that the list may lead to double-counting which should be avoided. For example, if systems are integrated into existing urban projects, such as the city centre redevelopment projects in San Diego and Newcastle, and the regeneration projects in Vancouver and St Louis, they should not be counted twice as urban planning policies. Such cases are noted in the table.

Table 6.12 The experience of the case studies with transport and urban planning policies

	Transport planning policies					Urban planning policies						
	Integrating system into regional planning	Integrating system into existing urban projects	Locating stations at trip attractors or generators	Integrating bus services with new system	Providing car parking at stations	Adapting plans to the new system, ie rezoning	Incentives of transit-oriented development	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre redevelopment projects / actions	Urban renewal projects
Miami				⊗	●		⊗	●	⊗			⊗
St Louis		O	●	●	●	●	●		●		●	(1)
San Diego		●	O	●	●	●	●	O		O	(1)	
Sacramento				●	●		⊗		⊗	●		
Vancouver	●	●		●		●	●	●	●			(1)
Tyne/Wear	O	●		●(2)	O					●	(1)	
Manchester					O					●	●	
Sheffield		⊗			O							⊗

Key: ● The policy has been effective in enhancing the success of the system.
⊗ The policy has been implemented but failed to have significant effects (on the success of the system).
O It is not certain whether the policy had any effect on the performance of the systems.

Notes: (1) These are the projects that the systems were integrated into (the second transport planning policy); therefore, they are not shown under urban planning policies to avoid double-counting.
(2) Policy was implemented and was effective during the first 5 years of the operation of the system.

The table shows that in St Louis, Vancouver, and San Diego, the majority of these policies were implemented and have been effective in enhancing the success of the systems. It is remarkable that in Sacramento many urban planning policies have been implemented but failed to be effective. In Miami too, some policies have failed to be effective. Evidence suggests that some of the urban planing policies may not be effective in urban areas which are very unsuitable for urban rail investment. That is because the urban form is very difficult to change by using an urban rail system if the form of the city and the community values in the city are strongly in favour of private transport and strongly against transit oriented development. In two such cities, Miami and Sacramento, the effects of policies that were aimed at attracting development and increasing the development densities along urban rail corridors have been negligible.

Ineffectiveness of some urban planning policies in Sacramento and Miami reveals an important aspect that the framework must address. Urban planning policies may fail in areas which are extremely unsuitable for urban rail investment; therefore, the framework must evaluate the policies in relation to urban form, and include the possibility of some policies being ineffective.

As observed with the operating policies, transport and urban planning policies have not been implemented in the British cities as extensively as they have been in the North American ones. There are several reasons for this. First, since 1986, there have been no metropolitan planning governments in British cities, hence little effective comprehensive planning. Lack of an upper tier government that would co-ordinate transport investments with other urban investments can to some extent explain why there were very few urban plans and policies supportive of rail systems. Another point, which is again connected with the lack of policy co-ordination in British cities, is that over the past two decades, urban planning has been very much fragmented as a result of the planning actions initiated by Central government. For example, certain areas suffering from economic decline were designated Enterprise Zones: planning rules were relaxed in these areas with the anticipation that private developers would be attracted for the redevelopment of the area. The consequence, in Newcastle, was that in an area that was not served by the Metro, a large regional shopping centre was built, which affected Newcastle city centre as well as the patronage of the Metro. Another example of Central government intervention in planning was the Urban Development Corporations. The effects, in terms of losing policy co-ordination, have been significant, particularly in Sheffield. The lack of policy co-ordination between local planning agencies and the Sheffield Development Corporation (SDC) had consequences for the integration of the regeneration project with the tram project. Another reason for higher numbers of policies in North American cities may be because entrepreneurial approach in planning is more common in these cities. Urban planning policies are generally aimed at attracting private developers to invest along the urban rail systems. North American local governments, which traditionally employ corporatist techniques in planning, as discussed in Chapter 4, have been very successful in introducing attractive policies for the private sector. It seems that British local authorities, whose planning approach is discussed to have transformed from regulationist to entrepreneurial, have not yet adopted these techniques as successfully as their North American counterparts. A final reason why British cities implemented fewer policies compared to their North American counterparts may be that car-oriented urban development and its negative consequences is much more severe an urban problem in North American cities, particularly in the USA, than in British ones. For example, in all levels of government in California, creating transit oriented development is a policy with a very high priority. Therefore, an urban rail investment in an American city may be perceived as a more valuable instrument in supporting transit oriented development plans compared to British cities. As for Vancouver, the outstanding co-ordination of municipal plans with transport investment may be explained by the tradition of planning and local government in Canada. It was noted in Chapter 4 that the community is more tolerant of government intervention and planning in Canada than in most other western countries, and that local governments in Canada tend to behave in a non-partisan approach to urban development.

In order to include the transport and urban planning policies in the planning framework, the total number of effective policies are added to the sum of the total points gained from External and Planning Factors and Operating Policies. The results are shown in Table 6.13.

Table 6.13 Demonstrating the framework on the case studies

	Total of outcomes of External and Planning Factors (Figures 6.1, 6.3, 6.5, 6.7, 6.9, 6.11)	Operating policies (effective policies)	Transport and urban planning policies (effective ones)	Total
Miami	1	0	2	**3**
St Louis	4	4	7	**15**
San Diego	7	3	5	**15**
Sacramento	5	2	3	**10**
Vancouver	10	5	7	**22**
Tyne/Wear	9	0	3	**12**
Manchester	11	1	2	**14**
Sheffield	8	1	0	**9**
	out of 14	out of 6	out of 12	out of 32

6.6 APPLICATION OF THE FRAMEWORK

The planning framework that has been developed in this chapter has two functions. First, it predicts how successful a new urban rail system is likely to be. The prediction is based on four sets of factors, which are the inputs to the framework: external factors, planning factors, operating policies, and supporting policies. The second function of the framework is to indicate ways to enhance the success of the urban rail system in question. This second part is applicable not only to new urban rail systems, but also to the ones that are already operating.

Table 6.14 shows how the planning framework estimates the success of the eight case studies, and compares these estimates with observations of success of the systems. The estimates do not contradict the observations made in Chapter 5. This is not surprising since the design of the framework is based on the case study analysis, and therefore it is expected to reproduce the observations.

The results of the framework are comparable and close enough to satisfy the purpose of the study because the research is qualitative, and the numerical presentations are used merely to amplify the discussions. It would be misleading to try to refine the framework in order to make it produce exactly the same numerical values. Therefore, values need to be considered in a relative sense. For example, Vancouver SkyTrain is assigned the highest point by the framework, and that is compatible with the performance analysis in Chapter 5. The systems in St Louis and San Diego, which were observed to be the second most successful systems, are assigned the next highest points. Manchester Metrolink scored slightly fewer than these two systems, and indeed it was observed slightly less successful than them. Tyne and Wear Metro scored less than these three systems, but more than Sacramento and Sheffield, which is also compatible with its performance as observed in Chapter 5. Miami Metrorail, the least successful system, is assigned the lowest point. As a result, based on the four sets of factors, the framework is capable of reproducing the observations regarding the success of systems; however, to make it applicable to other urban rail systems, it needs to be validated against other systems, which is the task of the next chapter.

Table 6.14 Success: comparison of framework results with the observation

Systems ranked in order of success from the framework	Framework estimates		Observation (based on the analysis in Chapter 5)	
	Points	Ranking	Number of criteria fulfilled	Ranking
Vancouver SkyTrain	22	1	10	1
St Louis MetroLink	15	2	8	2
San Diego Trolley	15	2	8	2
Manchester Metrolink	14	3	7	3
Tyne and Wear Metro	12	4	6	4
Sacramento Light Rail	10	5	3	5
Sheffield Supertram	9	6	2	6
Miami Metrorail	3	7	1	7
	out of 32		out of 15	

In addition to the estimation of success, the framework can provide recommendations on how success can be enhanced. To enhance the success of systems, the focus of the framework is on operating and supporting policies, and to a limited extent on planning factors. External factors are included as the inputs, implying how the operating and supporting policies should be shaped. Factors regarding the route location are also inputs because decisions regarding routes depend on many local factors, and it is not possible to make general recommendations that can apply to all cities. As for design features, certain recommendations can be made for systems that are being planned; however, they cannot be applicable to systems that are already planned. As a result, recommendations are mostly on the policies.

All operating and supporting policies are likely to enhance the success of urban rail systems; however, some policies are particularly important for cities where the external factors or route locations are not appropriate for an urban rail system. Therefore, when the framework is applied to systems for recommendations on enhancing success, the outcomes of the framework regarding the External Factors and Route Location should be considered. Table 6.15 provides a list of the outcomes, for which implementing some of the policies may be very important. These outcomes represent factors which are not very supportive of urban rail investment. Policies that are recommended in corresponding boxes can help the systems overcome the possible negative effects of these factors. Recommendations are not made for the outcomes that indicate supportive factors because if the factors are suitable, there is no need to put special emphasis on a particular policy. All policies, in general, can help enhance the success of systems.

Among the recommended policies, some are transport planning policies that are likely to be implemented during the planning of the systems. Therefore, when applying the planning framework to systems that are already planned, there may not be a scope for the implementation of some of them, such as integrating the system into regional planning and into other urban projects. These recommendations are included; however, if the development of the urban rail system is at a stage when it is too late to implement these policies, they will have to be ignored.

The recommendations in Table 6.15 are also summarised in Table 6.16, which shows, for each different situation, the group of policies that needs to be given priority in implementation. Each tick in the table indicates that the corresponding policy may help enhance the success of the system. For example, if factors regarding the economic vitality of the CBD are not suitable, city centre redevelopment projects and urban planning policies that focus on the central areas should be given priority. Such policies may also be helpful under certain conditions when factors appear to be suitable. It will be remembered from Figure 6.1 that if the CBD is not the main centre for employment and retail activity, but the system is designed to serve other sub-centres, this is regarded as a suitable factor. However, designing the system to serve other sub-centres may lead to the decline of the CBD; therefore, precautions should be taken. Redevelopment and pedestrianisation actions and other policies to encourage development in the CBD can prevent decline.

Table 6.15 Recommendations to enhance the success of urban rail systems

Factors which require specific policies to be given priority:	What the aim of the policies should be:	Which policies should be implemented:
The **CBD** is not vital economically (*outcome of Figure 6.1 is 0 or 1*)	To revitalise the city centre, and attract development there	• City centre redevelopment projects • Pedestrianisation in the city centre • Locating development at city centre stations • Joint development projects and TOD schemes to attract developers to central stations
The **CBD** is not the main centre and the system serves other sub-centres (*outcome of Figure 6.1 is 0 or 1*)	To ensure that the CBD will not decline as a result of the urban rail system serving other sub-centres	• City centre redevelopment projects • Pedestrianisation in the city centre • Locating development at city centre stations • Joint development projects and TOD schemes to attract developers to central stations
The **urban form** is not suitable for urban rail investment (*outcome of Figure 6.3 is 0 or 1*)	To improve the urban form to make it more public transport friendly (to increase the patronage in the long term) To increase patronage in the short term	• Integrating system into regional plans and existing urban projects (so that it is supported by them) • Adapting plans to the system • Joint development projects and TOD schemes at stations • Locating development at stations • Providing car parks at stations • All operating policies
Public transport usage is low; public transport is regarded unsafe or local support for the project is low (*outcome of Figure 6.5 is 0 or 1*[1])	To increase the attraction of the system and improve its image	• Providing frequent services • Introducing travelcards • Offering free transfers to buses • Offering free travel on the system • Marketing, advertising • Providing security staff on board and at stations
Income levels of citizens that the system serves are not suitable (*outcome of Figure 6.7 is 0*)	To attract car users (if the system serves medium and high income) To avoid competition with buses (if the system serves low income)	• Providing frequent service • Offering free travel on the system • Providing car parks at stations • Introducing travelcards • Integrating buses and the system in routes and in fares (If the public transport regulatory regime does not allow the implementation of these policies, see the box below)
The **public transport regulatory regime** is not suitable (*Public transport systems cannot be integrated*)	To increase the attraction of the system and help it compete with buses	• Providing frequent services • Introducing travelcards (for the rail system only) • Offering free travel on the system • Marketing, advertising • Providing security staff on board and at stations
The **route location** is not suitable (*outcome of Figure 6.9 is 0 or 1*)	To design the system to be compatible with urban plans and to develop the corridor To revitalise the area (if there are declining areas)	• Integrating system into regional plans and urban projects • Adapting plans to the system • Joint development projects and TOD schemes at stations • Locating development at stations • Urban renewal/rehabilitation projects

(1) If local support for the project is low, these policies should be considered regardless of the outcome of the Public Transport factors.

Table 6.16 Policies that should be implemented to help systems overcome the negative effects of unsuitable factors

	Providing frequent service	Offering free transfers to buses	Travel-cards	Offering free travel	Marketting and advertising	Providing security staff	Integrating system into regional planning	Integrating system into urban projects	Locating stations at trip attracters	Integrating buses with the new system	Providing car parks at stations	Adapting plans to the new system	TOD incentives	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre re-development projects	Urban renewal projects
The CBD is not vital economically													✓	✓	✓	✓	✓	
The system serves other sub-centres													✓	✓	✓	✓	✓	
The urban form is not suitable	✓	✓	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓			
Public transport usage is low (1)	✓	✓	✓	✓	✓	✓												
System serves high income levels	✓			✓							✓							
System serves low income levels			✓ (2)							✓ (2)								
The route location is not suitable							✓	✓				✓	✓	✓	✓			✓
Buses are deregulated	✓		✓	✓	✓	✓												

Each tick indicates that the framework advices the corresponding policy to be impelemented as a measure to enhance success.
(1) If local support for the project is low, these policies should be considered regardless of the ourcome of the Public Transport factors.
(2) If the transport industry does not allow the implementation of these policies, i.e. buses are deregulated, then policies recommended in the last column can help enhance the success of the system.

If factors regarding the urban form are not suitable, urban and transport planning policies that help co-ordinate the transport plans with the urban plans should be implemented. These policies can help to transform the urban area to a more public transport friendly environment, and hence contribute to the patronage of the system in the long term. However, it would be necessary to ensure a reasonable level of patronage in the short term too. Most operating policies listed can help attract passengers to the system in the short term. Among them, providing security staff may not be a priority policy unless Figure 6.5, which addresses the safety issue, indicates otherwise.

If socio-economic factors indicate that public transport usage is low, and public transport is regarded unsafe, or local support for the project is poor (outcome in Figure 6.5 is 0 or 1), all operating policies can help to enhance success. In fact, regardless of the level of public transport usage, these policies should be implemented if local support for the project is low. Low support from citizens may result in the citizens using predominantly buses and avoiding the system, as experienced in Miami.

If factors regarding the economic profile of citizens indicate that the system will serve high income areas, providing high frequency services, offering free travel on the system (to help some citizens overcome the threshold of using a public transport service for the first time), and providing car parks at stations may attract car users to the urban rail system. If, on the other hand, the system will serve low income households, and bus fares cannot be controlled, ways of integrating fares of buses and the urban rail system should be sought. However, if the transport operating regime does not allow the implementation of such policies, i.e. the buses are deregulated, then most operating policies can increase the attraction of the urban rail system and help it compete with buses.

In addition to external factors, factors regarding the location of routes of the systems may also require the implementation of certain policies. If the routes of the system are located in undeveloped or declining areas, urban planning policies should be implemented to develop the corridor. If the routes are not compatible with urban development plans (outcome in Figure 6.9 is 0), then transport planning policies that help to improve the co-ordination of transport and urban plans should also be employed if possible. For the development of declining areas, urban planning actions may not be sufficient, and a more comprehensive planning approach may be needed. Therefore, these areas should first be improved with the help of urban renewal or rehabilitation projects, and then urban planning policies can be applied.

Although urban planning policies are useful in making an urban area more public-transport friendly, they may not be effective, as mentioned before, in areas that are very much car-oriented as well as in areas where the citizen values are very much against public transport and high-density development. It is very difficult to determine the type of urban areas where policies will fail to be effective. It is not easy, for example, to identify clearly the differences between the urban areas in San Diego and Sacramento; hence, it is difficult to determine the factors which made policies work in the former one and fail in the latter. It is known that in Sacramento there is a very negative attitude towards high density development, but this is an attitude common in almost all American cities, particularly the Californian ones. It requires further research to determine exactly what makes policies fail, and it is not possible to analyse this issue in depth within the scope of this research. However, it is important to incorporate this issue into the planning framework to some extent. Therefore, as a final note to the policy recommendations, it should be added that if the factors regarding the urban form and public transport are very unsuitable for urban rail investment, then planners must be aware that some policies may fail to be effective. In such cases, very comprehensive plans and policies aimed at changing urban growth patterns would be needed since the suggested policies are only piecemeal solutions. As a result, it can be argued that if the Urban Form part of the framework indicates that the urban area is low density; *and* the Public Transport part of the framework indicates that public transport usage is not high; *and* the Income Levels part of the framework indicates that the system serves high income areas with low public transport usage at the corridors, then policies may not be effective because the area may be very unsuitable for public transport.

In addition to the policy recommendations, there are two issues regarding the design of the systems which were mentioned earlier in Section 6.3.3.

- If there is competition from other public transport services, and if the urban rail system will not have high priority in signalling relative to cars, it may be preferable not to plan the system with too frequent stops or high proportion of street-running segments.

- If crime and personal safety are important issues in an urban area, it may be preferable not to plan the system as fully segregated or fully automatic, because both features may lead to an image of being isolated.

Nevertheless, if these design features are chosen in spite of their unsuitability, they may not necessarily hinder the success of an urban rail system. They can be addressed through policies. The first issue can be overcome by employing operating policies that can increase the attraction of the urban rail system, and help it compete with buses. The second issue can be overcome by employing additional security staff on board, at stations, and at the car parks serving the system.

It was mentioned that all policies in general can help enhance the success of urban rail systems. In addition, some of the transport and urban planning policies can help improve the co-ordination between urban and transport planning. Among the transport planning policies, integrating the system into regional planning and existing urban projects is likely to improve the compatibility of the rail system with urban plans and projects. Among the urban planning policies, adapting plans to the new system, public-transport friendly development, joint development projects, and locating development at stations can help improve the compatibility of the urban plans and the urban environment to the urban rail system. It may be expected that these policies would be implemented in cities where there already is a good level of co-ordination between urban and transport planning. On the contrary, this was not the observation. When these policies were implemented, it was either coincidental or led by a political actor; however, once they were implemented they helped attain a certain level of co-ordination, and evidence suggests that once co-ordination is achieved between the plans, it was very likely to be sustained.

As a result, the above policies are likely to provide co-ordination between urban and transport planning in urban areas where co-ordination may be difficult to attain spontaneously. It is particularly important to formulate these policies at early stages of developing the urban rail system, because the analysis showed that early stages of planning were the only times when the different planning agencies were involved in the development of the systems, and that policies formulated at these stages helped sustain co-ordination between the agencies, as evident in Vancouver and San Diego.

6.7 CONCLUSION

In this chapter, the findings of the case study analysis have been used for developing a planning framework for urban rail systems. The framework addresses four main sets of factors: external factors, planning factors, operating policies, and supporting policies. How these factors interact with each other, and how they affect the success of urban rail systems, were observed throughout the case study analysis, and the planning framework has been designed on the basis of these observations.

The planning framework has two main products. The first is the estimation of how successful a new urban rail system can be. Information on external factors, planning factors, operating and supporting policies are the inputs to the planning framework, and the possible level of success of the system is the output. The second product of the framework is recommendations for making urban rail systems more successful. The framework reviews the external and planning factors for an urban rail system, and if some of these factors are unsuitable for the success of the systems, it makes recommendations on how they can be improved.

The planning framework has been developed through the analysis of the eight case studies. It has been demonstrated in the chapter that the framework is, therefore, capable of reproducing the observations regarding how successful these systems are. It is important, however, to ensure that the framework is applicable to other urban rail systems as well as the case systems. The next chapter, therefore, validates the planning framework against other urban rail systems.

7. VALIDATION OF THE PLANNING FRAMEWORK

7.1 INTRODUCTION

The planning framework which has been developed in the previous chapter is based on the analysis and experiences of the case studies. It is important, therefore, to ensure that it is applicable to urban rail systems other than the case studies. In this chapter, the planning framework is validated against nine other urban rail systems.

For testing the framework, all new generation urban rail systems in the United States, Canada, and Europe has been considered. Among the European systems, French examples are the most comparable ones to the British ones since others, German and Dutch ones in particular, are either inter-city light rail systems or upgrading of existing tram services. As a result, planners and operators of all new systems in the United States, Canada, and France were contacted and the systems for which information and requested data were provided have been included in the analysis. They are shown in Table 7.1.

Table 7.1 Urban rail systems against which the planning framework is validated

Country	City	Name of system	Type of system	Opening year	Length (km)
United States	Atlanta	Metro	metro	1979	62.2
	Baltimore	Baltimore Metro	metro	1983	25.0
		Baltimore Light Rail	light rail system	1992	48.9
	Los Angeles	Red Line	metro	1993	17.9
		Blue and Green Lines	light rail system	1990	57.0
	Portland	MAX	light rail system	1986	24.2
	San Jose	Light Rail	light rail system	1987	33.8
Canada	Calgary	C-Train	light rail system	1981	29.3
France	Rouen	Tramway	light rail system	1994	15.1

Note: Length of systems in the year 1998 are taken as the basis since performance analysis is based on the 1998 data. Extensions made after 1998 are not included.

It will be remembered that certain criteria were used in Chapter 3 to choose the urban rail systems to be studied, and they were explained in detail in Section 3.3.2. At this stage of the study, the city population and system length criteria were relaxed in order to be able to include as many systems as possible to validate the planning framework.

There are nine systems under investigation, but in total there are seven cities: five cities from the United States, two of which include both metros and light rail systems; one city from Canada, and one city from France. There are three metros: they are in Atlanta, Baltimore and Los Angeles. The latter two also have light rail systems. The remaining four systems are light rail. Atlanta metro is the oldest system. All the others opened for service in the 1980s and the early 1990s. The metro system in Atlanta, and the light rail systems in Baltimore and Los Angeles are the most extensive systems while the others have comparable lengths, the smallest being the tram in Rouen.

In the following sections, the planning framework is tested on the urban rail systems mentioned above. First, the success of the systems is measured using the same methodology as that used in Chapter 5. Secondly, the framework is applied to the systems and estimates are made regarding the level of success of each system. Thirdly, the estimates are compared with the observed level of success of the systems, and the accuracy of the framework is then assessed. It will be remembered that the planning framework has two functions: it predicts the success of systems, and it produces recommendations on how to enhance success. The subject of this chapter is the first function of the framework. That is because the validation of the framework is aimed at analysing how accurate the estimates of success are. Demonstration of the framework, which includes both estimating success and making recommendations to enhance success, are the tasks of the next chapter.

7.2 MEASURING SUCCESS: ATTAINMENT OF OBJECTIVES

7.2.1 Attaining a high level of patronage

Performance of the systems in terms of patronage is presented in Table 7.2. The indicator that compares passengers to route kilometres shows that Calgary C-Train and Atlanta

Metro are the most successful systems, followed by the tram in Rouen. The light rail systems in Baltimore and San Jose appear to be the least successful systems. In terms of number of passengers per vehicle, that is vehicle load, the light rail systems in Los Angeles and Portland are the most successful. Baltimore and Los Angeles Metros and San Jose light rail, on the other hand, perform poorly according to this indicator. Passengers per vehicle kilometres are highest in Calgary C-Train and Rouen Tram. Los Angeles Metro and LRT and Portland MAX also perform well while the systems in Baltimore are the least successful. Data for patronage forecast of the systems is limited. Data available shows that most systems were unable to attain their forecast level of patronage with the exceptions of Los Angeles LRT and Rouen Tramway.

Table 7.2 Performance indicators in attaining high patronage (1998)

	Passengers per route km	Vehicle load	Passengers per vehicle km	Forecast and actual patronage		
				Projected patronage	Actual patronage	Difference (%)
Atlanta Metro	1,250,836	22	2.18	N/A	N/A	N/A
Baltimore Metro	514,372	16	1.89	103,000	42,600	-59
Baltimore LRT	144,034	20	1.82	N/A	N/A	(below)
Los Angeles Metro	685,430	15	4.63	364,000	41,100	-89
Los Angeles LRT	419,015	38	3.27	54,700	84,425	+54
Portland MAX	489,506	37	4.30	42,500	19,700	-54
San Jose Light Rail	215,938	16	2.07	N/A	N/A	(below)
Calgary C-Train	1,419,795	27	13.96	N/A	N/A	N/A
Rouen Tramway	927,152	N/A	9.79	N/A	N/A	(above)
US average for metros	994,270	21	1.90			
US average for LRTs	341,068	26	2.88			
Canadian average for LRTs	1,241,096	N/A	N/A			
European average for LRTs	772,812	N/A	N/A			
French average for LRTs	1,221,106	N/A	N/A			
Average of the case study and test systems	597,243	27	2.85			

Source: Federal Transit Administration (2000); data supplied by planners and operators of the systems. Sources of forecast data are as follows: Pickrell (1990) for Baltimore Metro and Portland LRT; Walmsley and Perrett (1992) for Baltimore LRT and San Jose LRT; Kain (1988) for Los Angeles Metro; Richmond (1998b) for Los Angeles LRT; planners of the system for Rouen tram.

Notes: For Calgary, passenger km data was available for the year 1990. Therefore, vehicle load which is 27 is calculated by dividing the 1990 passenger kilometres by 1998 vehicle kilometres. If 1998 data for passenger kilometre were used, the outcome might have been higher.

Forecast and actual patronage are the average weekday patronage.

N/A: not available.

It will be remembered that three indicators were used in Chapter 5 to measure the success of systems: passengers per route kilometre, vehicle load, and comparison of forecast and actual patronage. Since data is not available for the forecast patronage of Atlanta Metro and Calgary C-Train, it is not possible to conduct a comparative analysis.

As an alternative, passengers per vehicle kilometre are observed. For vehicle load too, data could not be obtained for Rouen. Nevertheless, this is an indicator for which data is available for most of the systems; therefore, it will be used to conduct a comparison of the performance of the systems. As a result, passengers per route kilometre, vehicle load, and passengers per vehicle kilometre are used as the three indicators to measure success (Table 7.3).

Table 7.3 Performance of the systems in terms of patronage levels

	Passengers/ route km > relevant average	Vehicle load > 27 (the average of the case and test systems)	Passengers / vehicle km > 2.85 (the average of the case and test systems)	Overall success
Atlanta Metro	✓			✓
Baltimore Metro				
Baltimore LRT				
Los Angeles Metro			✓	✓
Los Angeles LRT	✓	✓	✓	✓✓✓
Portland MAX	✓	✓	✓	✓✓✓
San Jose Light Rail				
Calgary C-Train	✓	✓	✓	✓✓✓
Rouen Tramway	✓	✓[1]	✓	✓✓✓

(1) Vehicle load data is not available for Rouen; however, considering its good performance in other indicators and its patronage which exceeded the forecast, it is accepted to be successful.

The success of systems is measured by using the average values as in Chapter 5. When country and continent averages are not available, the performance of the systems is measured by comparing them to the average performance of case studies and test systems. In Chapter 5, in such cases, comparison was made with the average of the case study systems only, since data for test systems was not available at that stage. After obtaining data for test systems, the analysis in Chapter 5 has not been updated. It was decided that it was better not to revise the case study analysis retrospectively, but to only use data on the systems available at the time of the development of the framework.

As Table 7.3 presents, systems are given a tick if their passengers per route kilometre are higher than the relevant average, if their vehicle load is higher than the average of the case and test systems, and if their passengers per vehicle kilometre are higher than the average of the case and test systems. Data for vehicle load is not available for Rouen as mentioned. Given that the patronage of the system has exceeded the forecasts, the system is successful in terms of patronage; therefore, it will be regarded as successful in terms of the vehicle load indicator. As a result, the light rail systems in Los Angeles, Portland, Calgary, and Rouen are regarded as successful in attaining high patronage.

7.2.2 Building and operating the system cost-effectively

The financial performance of the systems is shown in Table 7.4. The metro investment in Los Angeles, metro and LRT investments in Baltimore, and LRT investment in San Jose have not been well utilised. The number of passengers they carry is too low to justify the cost incurred in their development. The light rail investments in Calgary and Rouen, on the other hand, are well justified since the capital cost is very low compared with the number of passengers carried. In terms of operating cost per passenger too, the performance of Calgary C-Train is outstanding. Atlanta Metro also performs well while the light rail systems in Baltimore and San Jose have the highest operating costs per passenger. These two systems perform poorly in terms of the passenger-staff ratio too. The most successful systems in this indicator are the ones in Calgary and Rouen.

Table 7.4 Financial performance of the systems (1998)

	Annual capital cost per passenger (£)	Operating cost per passenger (£)	Passengers per member of staff	Fare revenue per passenger (£)	Farebox recovery ratio (%)
Atlanta Metro	3.89	0.82	57,461	0.23	32
Baltimore Metro	7.28	1.73	29,101	0.51	31
Baltimore LRT	5.87	2.14	23,409	0.53	28
Los Angeles Metro	8.57	1.72	44,454	0.06	5
Los Angeles LRT	2.47	1.41	49,862	0.15	11
Portland MAX	2.15	1.23	32,724	0.25	20
San Jose Light Rail	6.27	2.49	25,688	0.48	20
Calgary C-Train	1.27	0.14	273,684	N/A	N/A
Rouen Tramway	1.50	1.73	103,704	0.64	37
US average for metros	3.63	1.39	43,257	0.29	27
US average for LRTs	3.10	1.33	44,077	0.37	25
Canadian average for LRTs	1.73	N/A	N/A	N/A	N/A
European average for LRTs	1.29	N/A	N/A	N/A	N/A
French average for LRTs	0.89	N/A	N/A	N/A	N/A
Average of the case and test systems	2.91	0.98	57,467	0.38	35

Source: Federal Transit Administration (2000); data supplied by planners and operators of the systems.
Notes: Farebox recovery ratio of Atlanta Metro is for the year 1990 and given by Kain (1997).
Capital costs are discounted to 1998, and annualised over 30 years at 8%.
There is a free fare zone in the city centre in Calgary, which is likely to generate short trips on the system. This may explain the low operating cost-passenger trip ratio for Calgary C-Train. (Also see notes in Appendix).
N/A: not available.

Fare revenue per passenger is highest for the Rouen tram, followed by the systems in Baltimore and San Jose. The systems in Los Angeles perform very poorly according to this indicator. The differences in the fare revenue indicators must be the results of factors such as number of journeys made with through fares as well as fare allocation between different operators, because all the systems have similar levels of fares in general. The farebox recovery ratios of the systems are, in general, low: they are below 40%. The tram in Rouen and the systems in Atlanta and Baltimore have the highest ratios while the systems in Los Angeles have the lowest. Calgary C-Train cannot be analysed because bus revenue and LRT revenue are not calculated separately in Calgary; hence, LRT revenue cannot be obtained.

The choice of indicators to be used for measuring the overall cost-effectiveness is to some extent determined by the availability of data. Data is available for most indicators except fare revenue data of Calgary C-Train. Therefore, annual capital cost per passenger, operating cost per passenger, and passenger-staff ratio are chosen as the three indicators to measure success (Table 7.5).

Table 7.5 Performance of the systems in terms of cost-effectiveness

	Annual capital cost/passenger < relevant average	Operating cost/passenger < £0.98 (the average of the case and test systems)	Passengers per staff > 57,467 (the average of the case and test systems)	Overall success
Atlanta Metro		✓		✓
Baltimore Metro				
Baltimore LRT				
Los Angeles Metro				
Los Angeles LRT	✓			✓
Portland MAX	✓			✓
San Jose Light Rail				
Calgary C-Train	✓	✓	✓	✓✓✓
Rouen Tramway			✓	✓

As the table shows, systems are given ticks if their annualised capital cost per passenger is lower than the average of other systems in their country or continent; if their operating cost per passenger is less than the average of case and test systems; and if their passenger-staff ratio is more than the average of case and test systems. Results indicate that Calgary C-Train is the most cost-effective system. The metro in Atlanta and the light rail systems in Los Angeles, Portland and Rouen have performed well in only one indicator while all other systems have failed to fulfil the criteria.

7.2.3 Increasing public transport usage

It will be remembered that three criteria were used in Chapter 5 to determine the performance of systems in increasing public transport usage. Systems were accepted successful if they resulted in an increase in the modal share of public transport, if they had increasing patronage, and if they did not cause a decline in bus patronage. Table 7.6 shows the performance of the test systems. Data provided by planners and operators have revealed that the patronage of all the systems is increasing and that they did not cause decline in usage of buses. In fact, Kain (1997) and Richmond (1998a, 1998b) have discussed for the systems in Atlanta and Los Angeles, respectively, that the introduction of rail systems caused a decline in bus usage because buses were reorganised to feed into them and this resulted in increased number of transfers which discouraged bus use. However, data about the trends in bus usage in these cities does not indicate a significant effect on overall bus patronage. It is concluded, therefore, that the systems did not cause a decline in the patronage on buses.

Table 7.6 Performance of the systems in increasing public transport usage

	Modal share of public transport increased	Patronage of the urban rail system is increasing	Urban rail system did not cause decline in bus usage	Overall success
Atlanta Metro		✓	✓	✓✓
Baltimore Metro		✓	✓	✓✓
Baltimore LRT		✓	✓	✓✓
Los Angeles Metro		✓	✓	✓✓
Los Angeles LRT		✓	✓	✓✓
Portland MAX	✓	✓	✓	✓✓✓
San Jose Light Rail		✓	✓	✓✓
Calgary C-Train	✓	✓	✓	✓✓✓
Rouen Tramway		✓	✓	✓✓

As for the effects of the systems on the modal share of public transport, it was stated by planners and operators of most systems that there was not a city-wide impact. For Baltimore, the operators stated an increase in the share of public transport modes in entire trips as a result of the new systems; however, information provided by Dunphy (1997) shows that this was not the case in Baltimore. Baltimore Metro opened in 1983, and Dunphy (1997) has shown that percentage of transit trips in Baltimore declined from 10% in 1980, to 7.6% in 1990.

In a number of cases, there is evidence of impacts along the rail corridors. In Portland, "public transport mode share to downtown increased from less than 10% to over 40% as a result of MAX" (Cani, 1997, p.255). Dueker and Bianco (1999) have also reported a gain in public transport mode share for commuting from 1980 to 1996. In Calgary too, modal share of transit trips to city centre increased in the early 1980s as a result of the fact that parking supply had lagged behind the employment growth in the city centre (Hubbell et al, 1997). Although scarcity of car parks was not a result of a transport policy introduced to support the C-Train, it helped its patronage and increased the overall public transport usage. As a result, the modal share of public transport increased in Portland and Calgary after the opening of the light rail systems.

7.2.4 Preventing or solving traffic congestion and associated environmental problems

The performance of the systems in attaining the objective concerning traffic congestion is measured by three criteria, as in Chapter 5. Systems are regarded as successful if they reduced growth in car usage, reduced traffic congestion, and improved the air quality. There was no evidence of reduction in the growth of car usage in the overall urban areas. Similarly, there was no evidence of a significant reduction in traffic congestion or an improvement in air quality. Data provided by the operators of Portland MAX indicates that MAX is estimated to keep 37,500 cars off the road each weekday. However, this may be an indicator to support the increased usage of public transport along the corridor (which was covered in the previous section) rather than an indicator of relief in traffic congestion. There is no evidence to assume that traffic volumes are lower than what they were before the introduction of the system. As a result, the systems are not regarded as successful in attaining the objective.

7.2.5 Improving the land use and urban growth patterns

It will be remembered from Chapter 5 that three sub-objectives were used to measure the attainment of the land-use objective: to stimulate development at the city centre; to stimulate development in declining slum areas; and to improve the pattern of urban growth by transforming it from a car-oriented to a transit-oriented pattern. If the systems are observed to attain the sub-objectives, they will be considered to be successful.

Table 7.7 presents the land-use impacts of the systems based on the information provided by their planners. For most of them, the information has also been verified by previous research and impact studies.

Table 7.7 Performance of the systems in attaining the land-use objectives

	To stimulate development in the city centre	To stimulate development in declining areas	To improve the pattern of urban development	Overall success
Atlanta Metro	✓	✓	✓	✓✓✓
Baltimore Metro			✓	✓
Baltimore LRT			✓	✓
Los Angeles Metro				
Los Angeles LRT				
Portland MAX	✓	N/A	✓	✓✓
San Jose Light Rail	✓	✓		✓✓
Calgary C-Train	✓	N/A		✓
Rouen Tramway	✓	✓	✓	✓✓✓

N/A: not applicable.

Atlanta Metro was reported to have stimulated development in the city centre and in declining old industrial areas, and have successfully channelled growth along itself. Walmsley and Perrett (1992) verify the positive impacts in the city centre and in declining areas, but argue that impacts in declining areas have been limited; however, considering that the information supplied by planners is a more recent data, Atlanta Metro is regarded as successful in stimulating development in declining areas. For Baltimore, planners indicated some impact on development densities, and this is presented in the table. Although Walmsley and Perrett argue that there were very few signs of developmental impact, their study was conducted very shortly after the opening of the Baltimore Metro and before the opening of the LRT; therefore, more recent data provided by the planners will be used as the basis of development impacts. Planners in Los Angeles indicated that the land-use impacts of the systems were insignificant, and this is verified by Loukaitou-Sideris and Banerjee (2000) who show that the light rail system in Los Angeles did not contribute to new development at station areas. Portland MAX, on the other hand, is a system well known for its significant impacts on land-use. The system stimulated development in the city centre (Cani, 1997) and contributed to the improvement of the urban growth pattern (Cani, 1997; Dueker and Bianco, 1999). The existing lines of the system do not run through declining or economically depressed areas; therefore, the objective regarding the development at such sites is not applicable to Portland MAX. The planners of San Jose Light Rail indicated that the system stimulated development in the city centre and at declining areas, and Cani (1997) also reports such positive land-use impacts. Calgary C-Train has been reported by its planners to have stimulated development in the city centre, and also have influenced urban growth patterns to a limited extent. Walmsley and Perrett (1992) also indicate positive impacts in the city centre, and they state that developmental impact at other parts of the system remained very limited because of the downturn of the economy and rapid decline in the demand for property in the 1980s. Bakker (1992) also states that the Calgary C-Train did not attract much development near its outlying stations, and argues that park-and-ride areas, which occupy the land near stations, are one of the reasons. The Calgary C-Train does not serve declining areas; therefore, the relevant objective is not applicable. Rouen Tramway is reported to have attained all three of the land-use objectives.

7.2.6 The overall success of the systems

The results of the performance analysis, which are shown in Table 7.8, indicate that Calgary C-Train is the most successful system, followed closely by Portland MAX and the tram in Rouen. Atlanta Metro and Los Angeles LRT follow these systems. The metro in Los Angeles and both systems in Baltimore, on the other hand, are the least successful ones. San Jose LRT is not successful either.

Table 7.8 The overall success of the systems

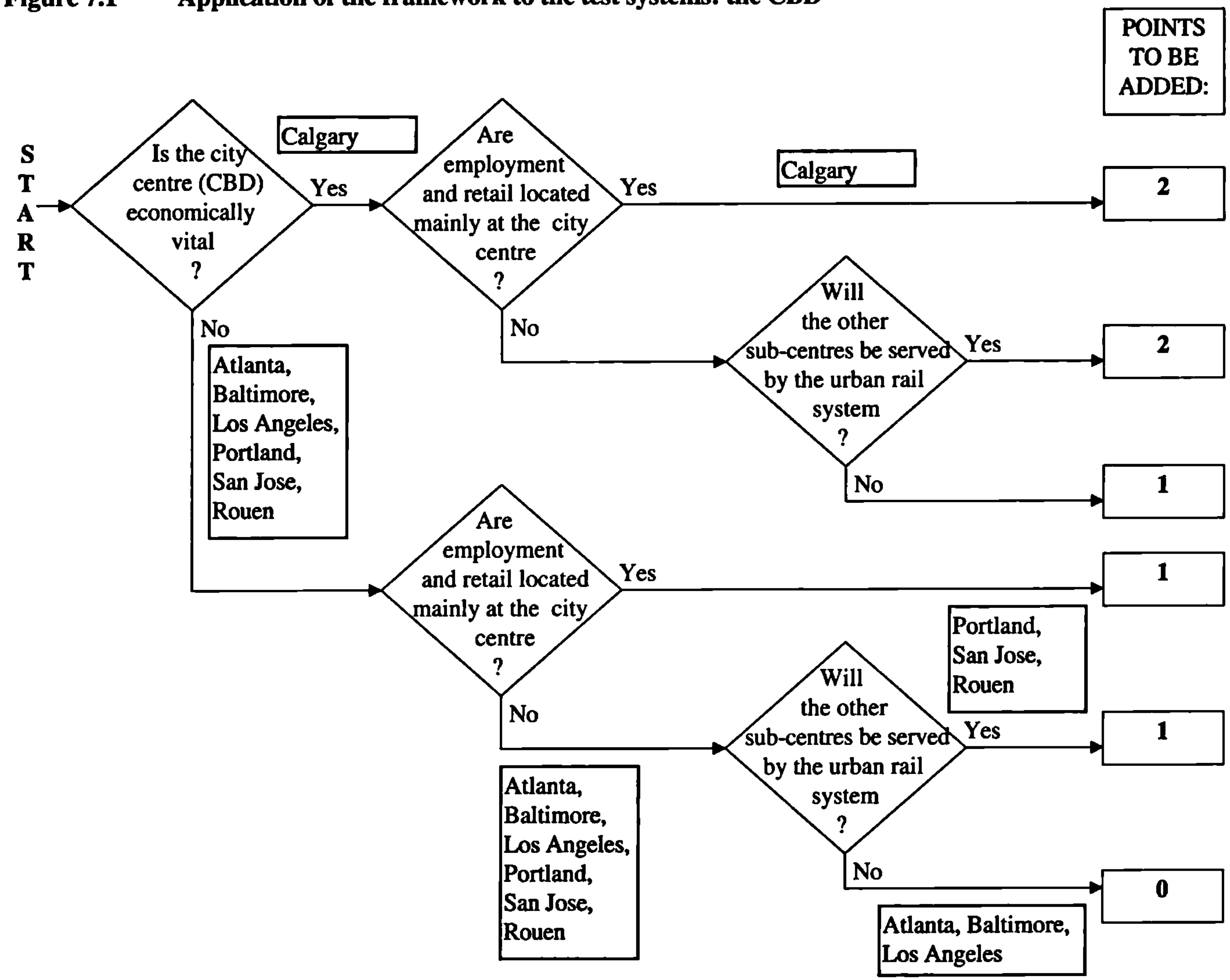
	To attain high patronage	To operate cost-effectively	To increase public transport usage	To solve car traffic and environmental problems	Land-use and development related objectives	Total number of ticks
Atlanta Metro	✓	✓	✓✓		✓✓✓	7
Baltimore Metro			✓✓		✓	3
Baltimore LRT			✓✓		✓	3
LA Metro	✓		✓✓			3
LA LRT	✓✓✓	✓	✓✓			6
Portland MAX	✓✓✓	✓	✓✓✓		✓✓	9
San Jose LRT			✓✓		✓✓	4
Calgary C-Train	✓✓✓	✓✓✓	✓✓✓		✓	10
Rouen Tramway	✓✓✓	✓	✓✓		✓✓✓	9

7.3 APPLICATION OF THE PLANNING FRAMEWORK: PREDICTING SUCCESS

The planning framework that has been developed in the previous chapter is applied to the test systems in this section. Figures 7.1 to 7.6 show the application of external and planning factors. When applying the framework to the test systems, data provided by planners has been used; however, the information is controlled and verified by other documents and studies whenever possible.

Figure 7.1 shows the application of the CBD part of the framework. It is important to remember that the questions aim to analyse the conditions before the opening of the urban rail systems. Therefore, cities which have economically vital CBDs today are not assigned points if their CBD was in decline during the planning and construction of the systems. For example, in Atlanta, Baltimore, Los Angeles, Portland, San Jose, and Rouen, the central areas were not economically vital. In Rouen and San Jose, the CBDs were weak because they were very small. Walmsley and Perrett (1992) and Cani (1997) verify that the CBD of San Jose was not a powerful city centre. Cani (1997) also reports that the CBD in Portland was not economically vital before the opening of the MAX. Unfavourable economic conditions of the CBDs in Atlanta and Baltimore are verified by Smith (1999) and Walmsley and Perrett (1992) respectively. Economic disparity between

Figure 7.1 Application of the framework to the test systems: the CBD



the CBD and the suburbs in these two cities are among the worst in American metropolitan cities (East-West Gateway Co-ordinating Council, 1996). The CBD of Los Angeles is not an economically important centre either: city centre employment represents less than 6% of regional employment and this share is steadily decreasing (Wachs, 1993, p.12). The CBD of Calgary, on the other hand, is a strong commercial centre.

Employment and retail are mainly located in the CBD in Calgary. In all other cities, there are other sub-centres. Among them, in Portland, San Jose, and Rouen, the new urban rail systems are designed to serve such centres. In Atlanta, Baltimore, and Los Angeles, although the systems serve some of the sub-centres, there is too much decentralisation for the systems to serve commercial and retail activities effectively. As a result, Calgary gains 2 points; Portland, San Jose, and Rouen gain 1 point; Atlanta, Baltimore and Los Angeles do not gain any points.

Figure 7.2 presents the application of the Urban Form part of the framework. Calgary and Rouen are the only high density cities. They have also developed along radial corridors, and these corridors have become the alignment of the light rail systems. Among the low density American cities, Portland and Baltimore consist of radial corridors, along which the rail systems were developed. In Atlanta, Los Angeles and San Jose, on the other hand, the urban form is dominated by grid-iron street patterns and urban sprawl. As a result, these systems do not gain any points. Baltimore and Portland gain 1 point while Calgary and Rouen gain 3 points.

Factors regarding the public transport usage, which are illustrated in Figure 7.3, are also favourable in Calgary and Rouen. Public transport usage is at medium levels (between 30 and 60% of all trips), and the light rail projects have high local political support. Therefore, they gain 3 points. In all the American cities, public transport usage is below 30% of the total trips. Public transport modes are generally considered to be safe, except in Baltimore where crime-related problems have been increasing: the city is ranked among the worst in terms of crime rate and crime trends (East-West Gateway Co-ordinating Council, 1996). Planners have also indicated that the rail projects had low local support; therefore, Baltimore does not gain any points. Local support for the rail systems in Los Angeles was also low. The systems gain 1 point because public transport

Figure 7.2 Application of the framework to the test systems: Urban Form

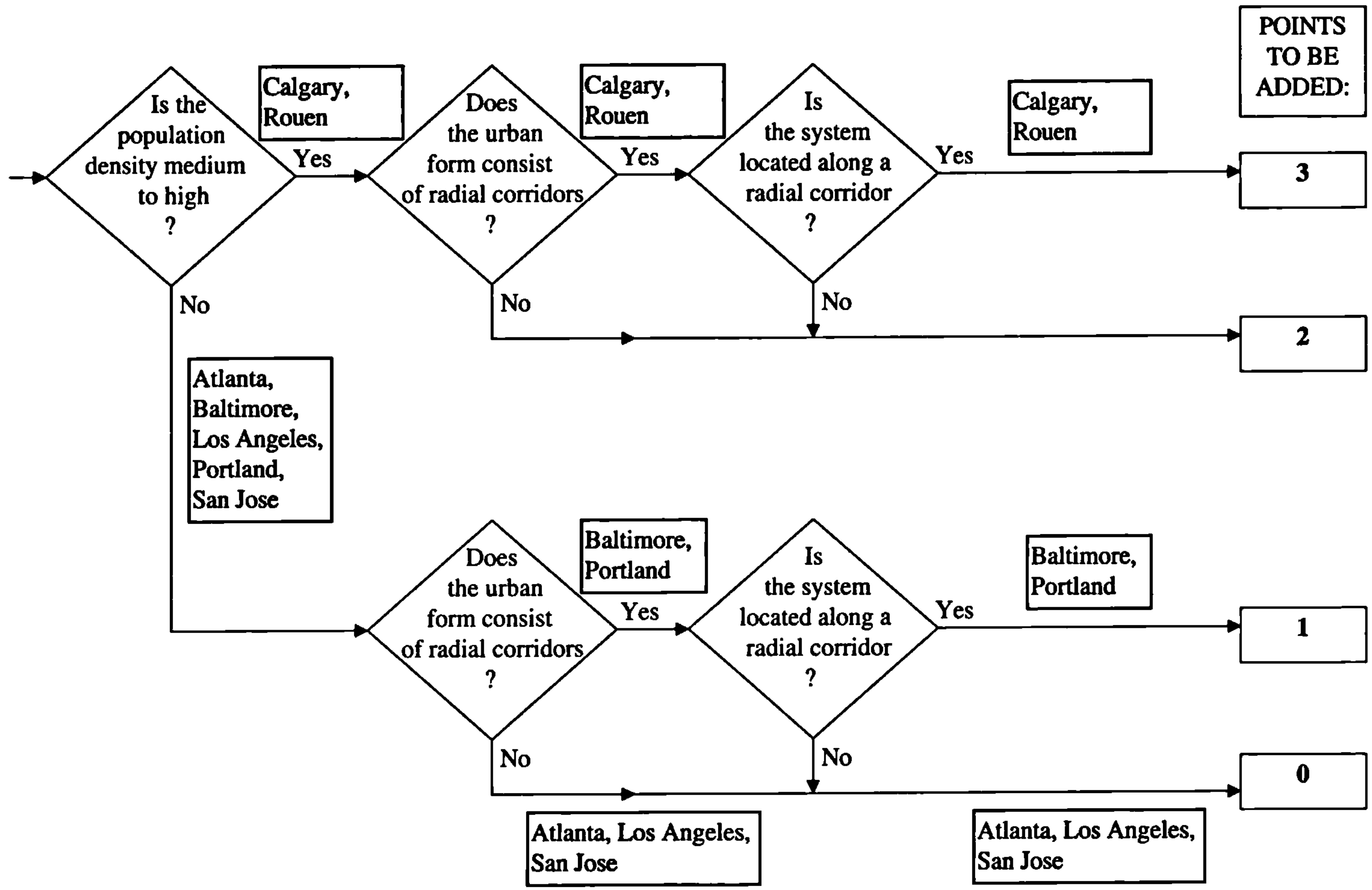
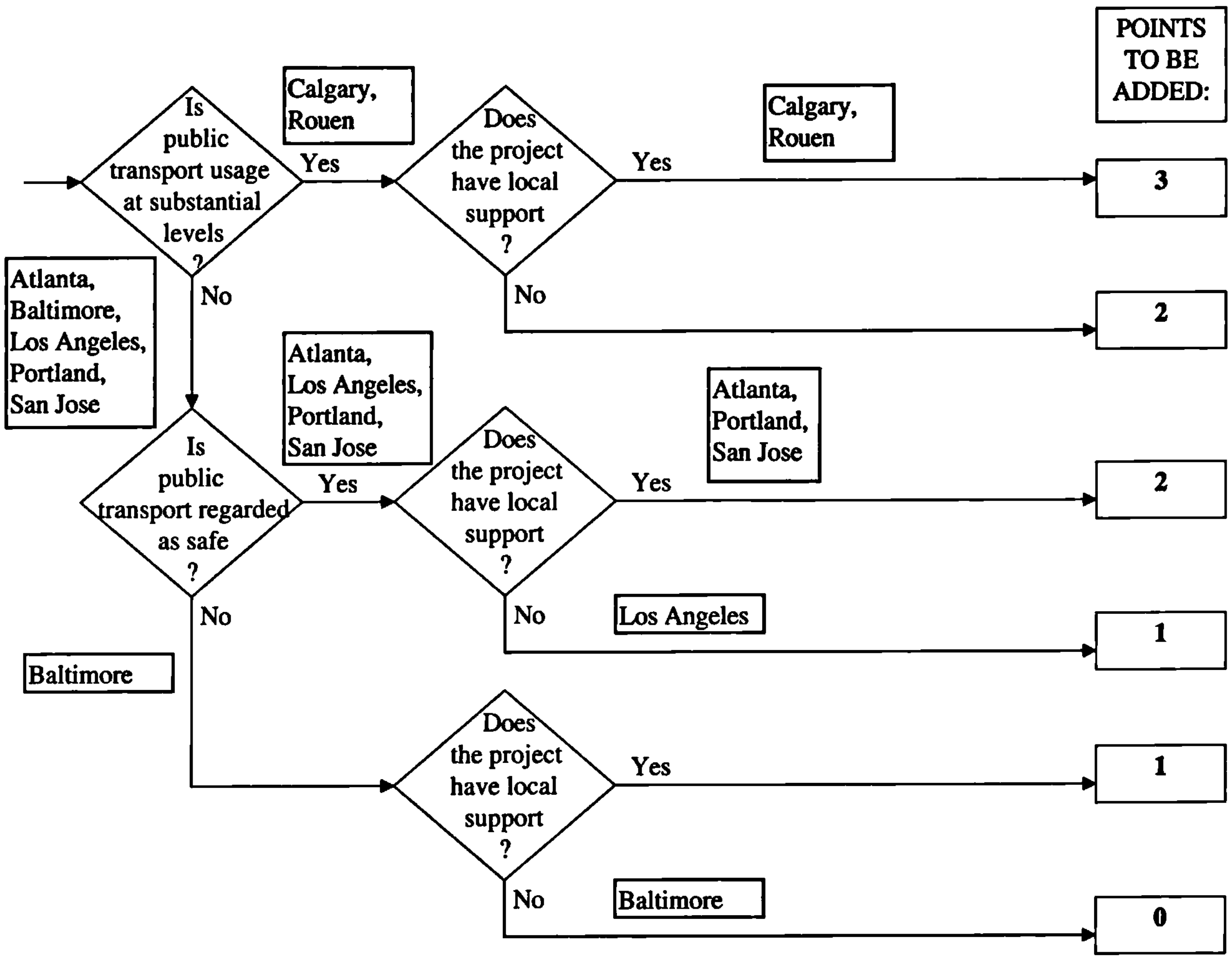


Figure 7.3 Application of the framework to the test systems: Public Transport

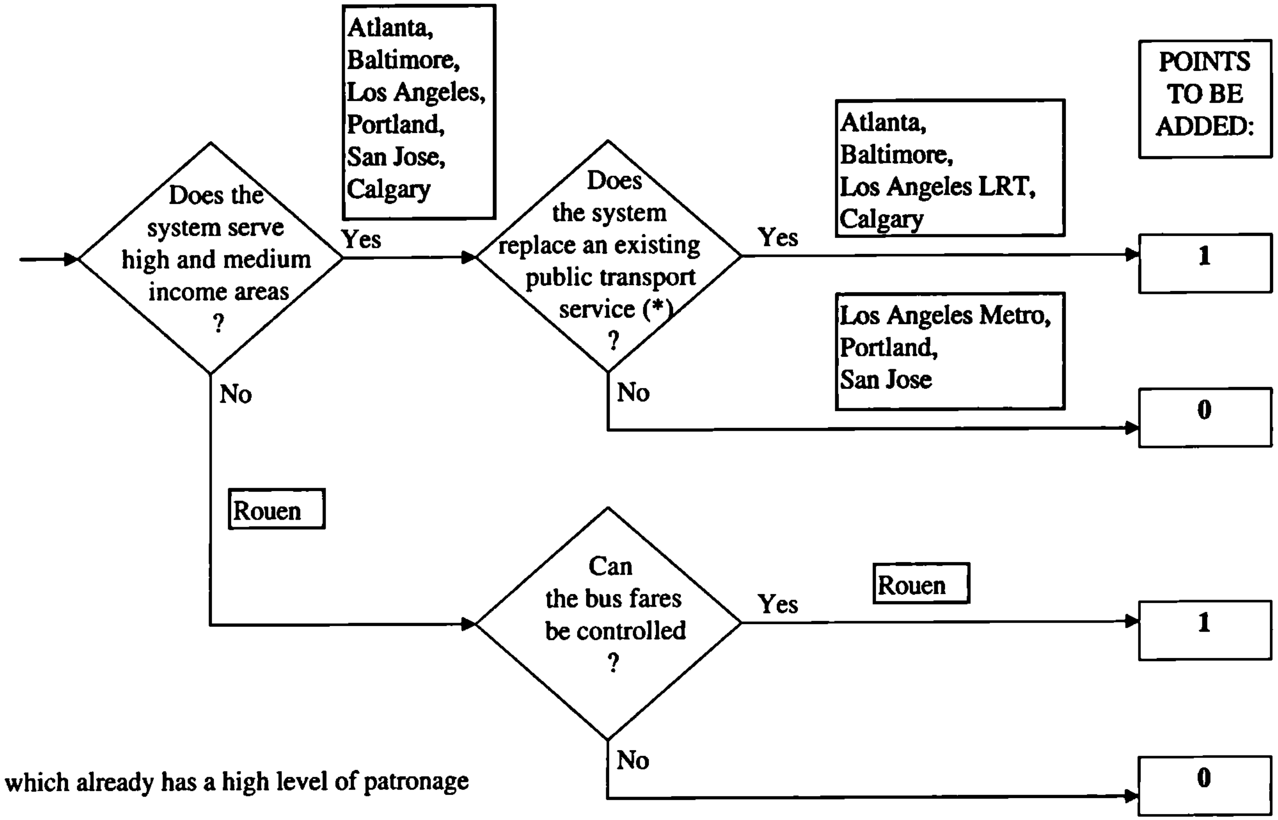


modes in Los Angeles are regarded safe. All the other American systems gain 2 points since the projects have local support and public transport modes are regarded safe.

Figure 7.4 illustrates the factors regarding Income Levels. Rouen tramway is the only system that serves low income neighbourhoods; however, bus fares can be controlled, and therefore the system gains 1 point. All the other systems serve areas with a combination of different income levels. In Calgary, the corridor where the rail system was located was a bus-only corridor; therefore, there was substantial bus patronage along the route. Among the American systems, Atlanta also used a previous busway for some parts of its corridor. Baltimore also replaced buses; more importantly, it used a corridor where there was demand for transit by the employees of a hospital that the line serves (Walmsley and Perrett, 1992). The systems in Portland and San Jose too replaced some bus services; however, it was not indicated by the planners whether they were profitable services and whether the patronage was substantially high at these buses. Since public transport trips in these cities are less than 10% of the total trips, it is concluded that public transport usage along the corridors were not very high either. As for Los Angeles, Wachs (1993) has reported that the alignments of the rail systems were chosen because of their availability and not because they were located in corridors of heavy travel volume. On the other hand, the light rail system replaced an express bus service which had a high level of patronage (Richmond, 1998b). As a result, Los Angeles LRT and the systems in Calgary, Atlanta and Baltimore gain 1 point while Los Angeles Metro, Portland MAX, and San Jose LRT do not gain any points.

The location of the systems are analysed in Figure 7.5. All systems were reported to be located in well-developed areas. Apart from the ones in Portland and Calgary, they all serve economically declining old industrial areas. In Portland and Calgary, the lines were not compatible with growth trends, but they were compatible with the development plans: both systems were based on regional development plans. Consequently, they gain 3 points. The locations of the systems in Atlanta, Baltimore, San Jose, and Rouen too were compatible with development plans: they were located in areas where the urban plans proposed development. Therefore, they all gain 1 point. It was reported for the systems in Los Angeles, on the other hand, that their integration with development plans was not very strong. As a result, the systems in Los Angeles do not gain any points.

Figure 7.4 Application of the framework to the test systems: Income Levels



(*) which already has a high level of patronage

Figure 7.5 **Application of the framework to the test systems: Route Location**

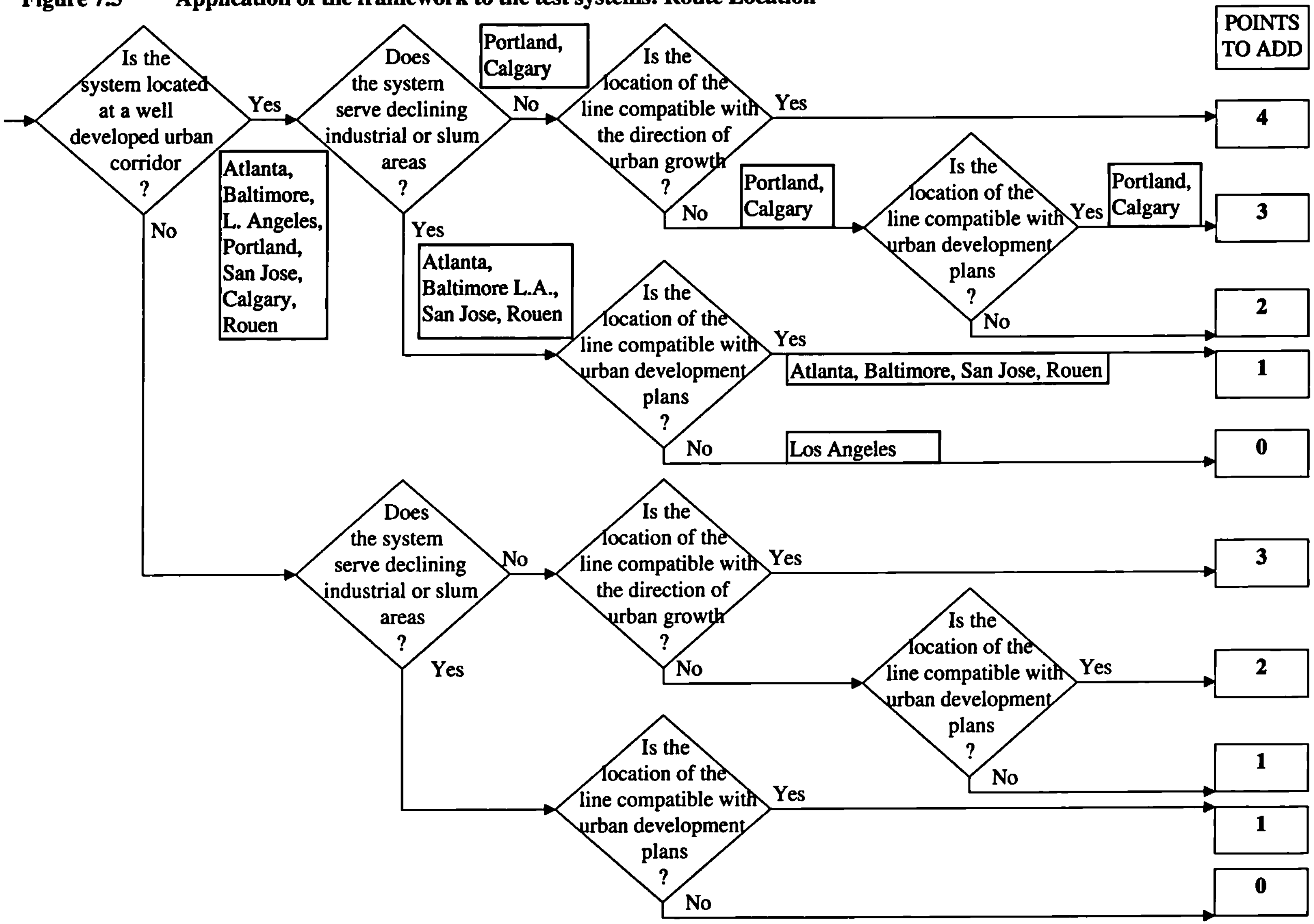


Figure 7.6 shows the cost of design features and their suitability to the urban areas. The light rail systems in Baltimore, Los Angeles, Portland, San Jose, Calgary, and Rouen cost less than £24 million per route kilometre; therefore, they all gain 1 point. The metro systems in Atlanta, Baltimore, and Los Angeles cost more than this amount, which is a consequence of their expensive metro technology. None of the three systems have gained high points from the framework regarding their urban form, public transport or income levels. Therefore, the high cost incurred in their development cannot be justified. As a result, they do not gain any points from this part of the framework.

The application of the framework regarding the operating policies is shown in Table 7.9. The policies implemented and their degree of effectiveness are based on the information provided by the operators of the systems.

Table 7.9 The experience of the test systems with operating policies

	Providing frequent service	Introducing travelcards	Offering free transfer to buses	Offering free travel	Marketing and advertising	Providing security staff on board and at stations
Atlanta Metro		●		●	●	●
Baltimore Metro		●			●	●
Baltimore LRT		●			●	●
LA Metro		●			●	●
LA LRT		●			●	●
Portland MAX			●	●	●	
San Jose LRT		●	●		O	●
Calgary C-Train		●	●	●	●	●
Rouen Tram	●	●	●	●	●	●

Key: ● The policy has been effective in enhancing the success of the system.
O It is not certain whether the policy had any effect on the performance of the system.

Table 7.10 presents the experience of the systems with transport and urban planning policies. The policies listed in the table are the same with those observed for the case studies, except that a new transport policy is added: car parking restriction. Limited car parking was a factor that was observed in Calgary. It contributed to the patronage of the system, and increased the share of public transport trips. It was not, however, introduced as a policy: as mentioned earlier, the boom in employment in downtown resulted in insufficient car parking. This factor can be incorporated in the framework as an external factor, for example by adding a factor to the Public Transport part of the framework.

Figure 7.6 Application of the framework to the test systems: Cost of Design

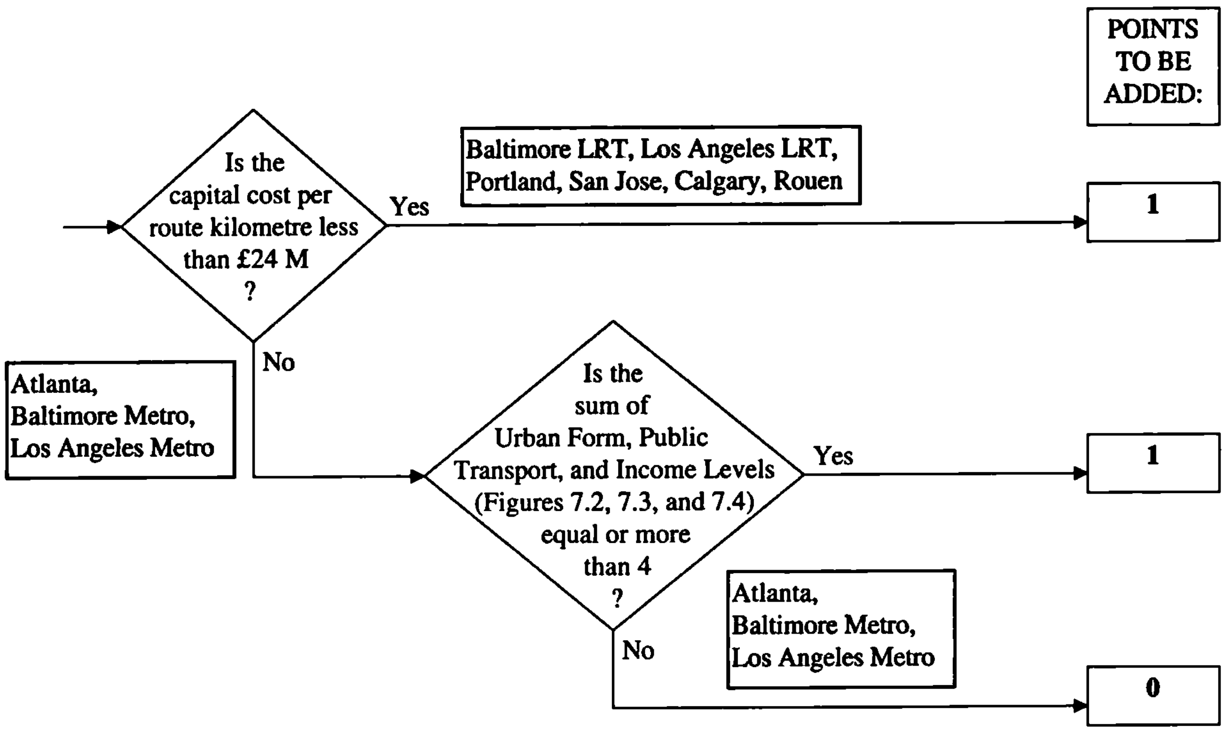


Table 7.10 The experience of the test systems with transport and urban planning policies

	Transport planning policies						Urban planning policies						
	Integrating system into regional planning	Integrating system into existing urban projects	Locating stations at trip attractors or generators	Integrating bus services with new system	Providing car parking at stations	Restricting car parks in the city or in the CBD [1]	Adapting plans to the new system, ie rezoning	Incentives of transit-oriented development	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre redevelopment projects/actions	Urban renewal projects
Atlanta			●	●	●			●	●	●	O	●	⊗
Baltimore Metro			●	●	●				O				O
Baltimore LRT			●	●	●				O				O
LA Metro			●	●	●		●		●	●			
LA LRT			●	●	●		●		●	●			
Portland MAX	●		●	●	●		●	●	●	●	●	●	
San Jose LRT	O		●	●	●		●	●	●	●	●	●	O
Calgary C-Train	●		●	●	●	●				⊗			
Rouen Tram	●			●			●					●	●

Key: ● The policy has been effective in enhancing the success of the system.
⊗ The policy has been implemented but failed to have significant effects (on the success of the system).
O It is not certain whether the policy had any effect on the performance of the systems.

(1) If there is scarce car parking in the city as a result of conditions other than a car restriction policy, this is a contributing factor; hence, it may be regarded as a policy and an extra point should be assigned.

This would result in an extra point if there is scarce car parking. Here, however, this factor is incorporated in the framework as a transport policy. If the scarcity of car parking is a result of a policy, an extra point can be gained. If this is not a result of a policy, but of other conditions in the city, as in Calgary, it will still be regarded under the policy section and an extra point will be assigned. The reason for locating the factor under policies is because it appears to be an important policy which should be included among the recommendations for system planners and operators.

The table shows that most of the policies were effectively implemented in Portland, San Jose, and Atlanta. Most of the information presented in the table can also be verified by supporting documents. There is evidence particularly for Portland that urban plans and the light rail system was very well integrated with each other, and that there were many supporting land-use policies which enhanced the success of the system, (Glick, 1992; Arrington, 1995; Dunphy, 1997; Cani, 1997; TRB, 1996a; TRB, 1997a). It is also worth noting that effective policies appear to be the direct consequence of the powerful regional government in Portland, which is a very rare example in the United States: city and county governments collaborated to devolve some of their powers and create a strong regional government (Cani, 1997). Development incentives in Atlanta and their effects in channelling growth has been reported by Walmsley and Perrett (1992). Examples of joint development projects in Los Angeles are evident from Bernick and Cervero (1997) and Dunphy (1997). Supporting policies in Calgary are evident from Bakker (1992) and Hubbell et al (1997); on the other hand, some of these policies, particularly urban planning ones, have failed to be effective because of a downturn of the economy in the mid-1980s which severely affected development and the property market (Walmsley and Perrett, 1992). Previous research also verified the lack of urban planning policies in Baltimore (Walmsley and Perrett, 1992; Dunphy, 1997) and limited impacts of the existing ones (Khasnabis, 1998). Evidence on San Jose, on the other hand, contradicts the information supplied by planners to some extent. Cani (1997) has stated that the success of some transit oriented development schemes has been limited; Dunphy (1997) has reported problems between planning agencies in reaching regional consensus on growth, which may have prevented development. The evidence from these studies is not explicit enough to help decide which policies in San Jose were effective and which were not. Therefore, the data supplied by the planners in San Jose will be used as the basis in predicting success; however, it should be born in mind that this may lead to overestimation of success.

It will be remembered from Chapter 6, Section 6.5, that urban planning policies may not be effective in certain urban areas. It was concluded that if the Urban Form part of the framework indicates that the urban area is low density; *and* the Public Transport part of the framework indicates that public transport usage is not high; *and* the Income Levels part of the framework indicates that the system serves high income areas with low public transport usage at the corridors, then there is the possibility that policies may fail to be effective. Among the test systems, all three conditions are met by Los Angeles Metro, Portland MAX, and San Jose LRT. Therefore, there is the possibility of overestimating the effects of policies, and consequently the success of the systems in these cities. On the other hand, supporting documents verify that urban planning policies have been successful in Portland. For San Jose, as mentioned, there are studies indicating that some policies have not been very effective. As a result, number of policies included in the framework for San Jose is likely to be more than the actual number of effective policies. For Los Angeles Metro too, effects of some policies may be limited.

The outcomes of the planning framework are shown in Table 7.11. The framework predicts Calgary C-Train to be the most successful system followed by Portland MAX and Rouen Tramway. San Jose Light Rail and Atlanta Metro are also predicted to be successful although it must be noted that the success of the former one may be overestimated for the reasons discussed above. The least successful systems are those in Baltimore and the metro in Los Angeles. The number of points gained by these systems are comparable to those gained by the systems in Sacramento and Sheffield, two of the least successful case systems. Los Angeles LRT is predicted to be more successful than these systems although it is not as successful as the others. Nevertheless, the points it obtained are comparable to those gained by the Tyne and Wear Metro; hence, the system is predicted to be fairly successful.

Table 7.11 Outcome of the planning framework: total points assigned

	CBD	Urban Form	Public Transport	Income levels	Route Location	Cost of Design	Operating Policies	Supporting Policies	Total (out of 33)
Atlanta Metro	0	0	2	1	1	0	4	7	**15**
Baltimore Metro	0	1	0	1	1	0	3	3	**9**
Baltimore LRT	0	1	0	1	1	1	3	3	**10**
LA Metro	0	0	1	0	0	0	3	6	**10**
LA LRT	0	0	1	1	0	1	3	6	**12**
Portland MAX	1	1	2	0	3	1	3	10	**21**
San Jose LRT	1	0	2	0	1	1	3	9	**17**
Calgary C-Train	2	3	3	1	3	1	5	7	**25**
Rouen Tramway	1	3	3	1	1	1	6	5	**21**

7.4 VALIDATION OF THE FRAMEWORK

The predictions from the planning framework are compared with the actual success of the systems in Table 7.12. The final column shows the total number of criteria satisfied by each system throughout the performance analysis that was conducted earlier in this chapter. To compare the results also with the case studies, the application of the framework to the case studies and their actual success as observed in Chapter 5 are added to the table.

The framework predicts Calgary C-Train to be the most successful system, and indeed it is the most successful one observed here. Portland MAX and Rouen tram are predicted to be the next successful systems, and the observation shows that the two systems are indeed the second most successful systems. San Jose LRT and Atlanta Metro are also predicted to be successful. The observation does not contradict the predictions for Atlanta. For San Jose, on the other hand, the prediction is inaccurate, probably because of the overestimation of the effects of policies as discussed above. The systems in Baltimore and the metro in Los Angeles are predicted to be the least successful systems, which is compatible with the observation. The LRT in Los Angeles is predicted to be more successful than the metro, and this prediction is also accurate when compared with the observation.

It appears that the framework is capable of producing accurate predictions for the success of systems, but there is one exception. San Jose light rail is estimated to be a very successful system while it is observed to have performed only slightly better than the least successful systems observed here: Baltimore metro and light rail and Los Angeles metro. It was mentioned earlier that there was the possibility of overestimating the effects of policies in San Jose. Planners in San Jose have indicated six urban planning policies that were effectively implemented and enhanced the success of the system. It appears that the success of these policies may have been overstated by the planners.

Table 7.12 Comparison of framework results with the observation

	Framework estimates	Observation: number of criteria fulfilled
Atlanta Metro	15	7
Baltimore Metro	9	3
Baltimore LRT	10	3
LA Metro	10	3
LA LRT	12	6
Portland MAX	21	9
San Jose LRT	17	4
Calgary C-Train	25	10
Rouen Tramway	21	9
Miami Metrorail	3	1
St Louis MetroLink	15	8
San Diego Trolley	15	8
Sacramento Light Rail	10	3
Vancouver SkyTrain	22	10
Tyne and Wear Metro	12	6
Manchester Metrolink	14	7
Sheffield Supertram	9	2
Points out of:	33	15 (14 for the Portland and Calgary systems)

This observation reveals an important aspect of the framework. Because the framework is a policy-based and a qualitative method of predicting success, an in-depth analysis of the policies is very important for achieving accurate results. When the framework is applied to systems which are already operating and which have already implemented policies, there is scope for conducting a detailed analysis of the effects of policies on the success of systems, and the framework then can be used as a tool of proposing further policies to enhance success. However, when the framework is applied to new systems, policies are either planned to be implemented or implemented so recently that it is not possible to analyse whether they are effective or not. However, the framework is designed to address the possibility that some policies may fail to be effective in urban areas that are not public-transport friendly (see page 259).

Apart from the case of San Jose, the estimates of the framework appear to be accurate. The results are also comparable to those of the case studies. Baltimore metro and light rail, and Los Angeles metro are observed to perform very similarly to Sacramento Light Rail, and they are assigned the same points by the framework. The LRT in Los Angeles is observed to be more successful: it was as successful as the Tyne and Wear Metro, and it scored the same point that Tyne and Wear Metro scored. Atlanta Metro is observed to perform similarly to Manchester Metrolink which had scored 14 from the framework. Atlanta Metro has scored 15, which is comparable to the score of Manchester Metrolink. For Atlanta Metro and the remaining systems (except for the special case of San Jose discussed above), the estimation of success seems to be reasonable, but perhaps very slightly overestimated. For example, Portland MAX and Rouen tram which satisfied 9 criteria are assigned 21 points, one point less than Vancouver SkyTrain which was observed to have satisfied 10 criteria. On the other hand, it should be remembered that while all systems are evaluated by the number of criteria out of 15, Portland MAX is evaluated out of 14 since the revitalisation of declining areas is not applicable to the system. The same argument is valid for Calgary C-Train. It satisfied 10 criteria out of 14. It is assigned 25 points, which is three points more than Vancouver SkyTrain which satisfied 10 criteria out of 15.

As a result, the estimates are regarded as compatible with the observations. Compared to the case studies, there is a very slight overestimation of success for the test systems. The overestimation seems to stem from the effects of policies. The case study analysis was based on field research and interviews with planners and experts from universities who have been involved in studies regarding the urban rail systems. For the test systems, on the other hand, analysis had to be based to a greater extent on the judgement of the planners of the systems. Planners may be more inclined to consider that the policies implemented had been effective and helped enhanced the success of systems. In addition, it has been discussed that some policies, particularly urban planning policies, may have not been very effective in urban areas that are not public transport friendly. As a result, the overestimation issue can be overcome through a more detailed analysis of the effects of policies.

7.5 CONCLUSION

The planning framework which was developed in the light of the experiences of the case studies has been validated against other systems in this chapter. The framework has two application areas: prediction of success and recommendations to enhance success. This chapter has focused on the first application area since its task was to analyse the accuracy of the predictions.

It has been shown that the framework can accurately predict the success of urban rail systems. On the other hand, an overestimate of success has been observed for one system due to an overestimate of the effects of policies. It has been concluded that an in-depth analysis of the effects of policies is required to obtain accurate results from the framework. In addition, it must be remembered that policies may have limited effects in urban areas that are very unsuitable for public transport.

In addition, the analysis of new systems has revealed that scarcity of car parks was an important factor which may affect success. The factor has now been incorporated in the framework, and restriction of car parks is included as a new transport policy which can enhance the success of systems.

8. APPLICATION OF THE PLANNING FRAMEWORK

8.1 INTRODUCTION

This chapter presents the application of the planning framework to new urban rail systems in Britain and Turkey. The first section analyses the factors behind the development of West Midlands Metro and Croydon Tramlink, two systems recently opened in England, and discusses how successful they are likely to be and how their success can be enhanced. The second section analyses new urban rail systems in Ankara, Izmir, and Adana in Turkey. The success of these systems is predicted, and recommendations are made to make them more successful.

8.2 NEW URBAN RAIL SYSTEMS IN BRITAIN

Two new light rail systems have recently opened for service in England (Table 8.1). Midland Metro is a 20.4 km light rail system between Birmingham and Wolverhampton, the two main towns in the West Midlands conurbation. The system started to operate in 1999. Croydon Tramlink is a 28 km rail system in Croydon, a large suburb of London. It started to operate in 2000.

Table 8.1 New British urban rail systems to which the planning framework is being applied

City (or conurbation)	Name of system	Type of system	Opening year	Length (km)
West Midlands	Midland Metro	light rail system	1999	20.4
Croydon / London	Croydon Tramlink	light rail system	2000	28

8.2.1 Predicting success

Planners and operators of Midland Metro and Croydon Tramlink have been contacted and questionnaires were sent in order to apply the planning framework to these systems. Figures 8.1 to 8.6 show the application of External and Planning factors, based on the information provided.

Figure 8.1 shows the factors regarding the CBD of Birmingham and Croydon. It was reported that Birmingham was a prosperous city and that the city centre is economically vital. The CBD in Croydon is also economically vital: it is one of the major sub-centres to which the employment in London has decentralised. Although there are other sub-centres growing in importance, Croydon remains a strong economic centre. Both employment and retail are agglomerated in the business centre of Croydon; therefore, the system gains 2 points. In Birmingham and the conurbation of West Midlands, urban activities, particularly retail activities, have been decentralising to out-of-town centres. However, the Midland Metro serves two major town centres: it connects the Birmingham town centre with Wolverhampton town centre. As a result, Midland Metro also scores 2 points.

Figure 8.2 shows the factors regarding the urban form. Both cities have medium densities of population. They also consist of radial corridors, where the rail systems have been located. As a result, they both gain 3 points.

The application of the factors regarding Public Transport are shown in Figure 8.3. In both cities, public transport usage is at medium levels (between 30 and 60% of total trips). It was reported for the West Midlands that public transport systems were not considered very safe in terms of personal security. Because public transport is at medium levels, however, it is believed that this issue will not affect the success of the system very much. The issue should, nevertheless, be addressed by relevant policies. It was also reported for the Midland Metro that there have been serious local opposition to the project. As a result, Midland Metro scores 2 points. The Croydon Tramlink is reported to have high local support; therefore, it gains 3 points.

Figure 8.1 Application of the framework to the new British and Turkish systems: the CBD

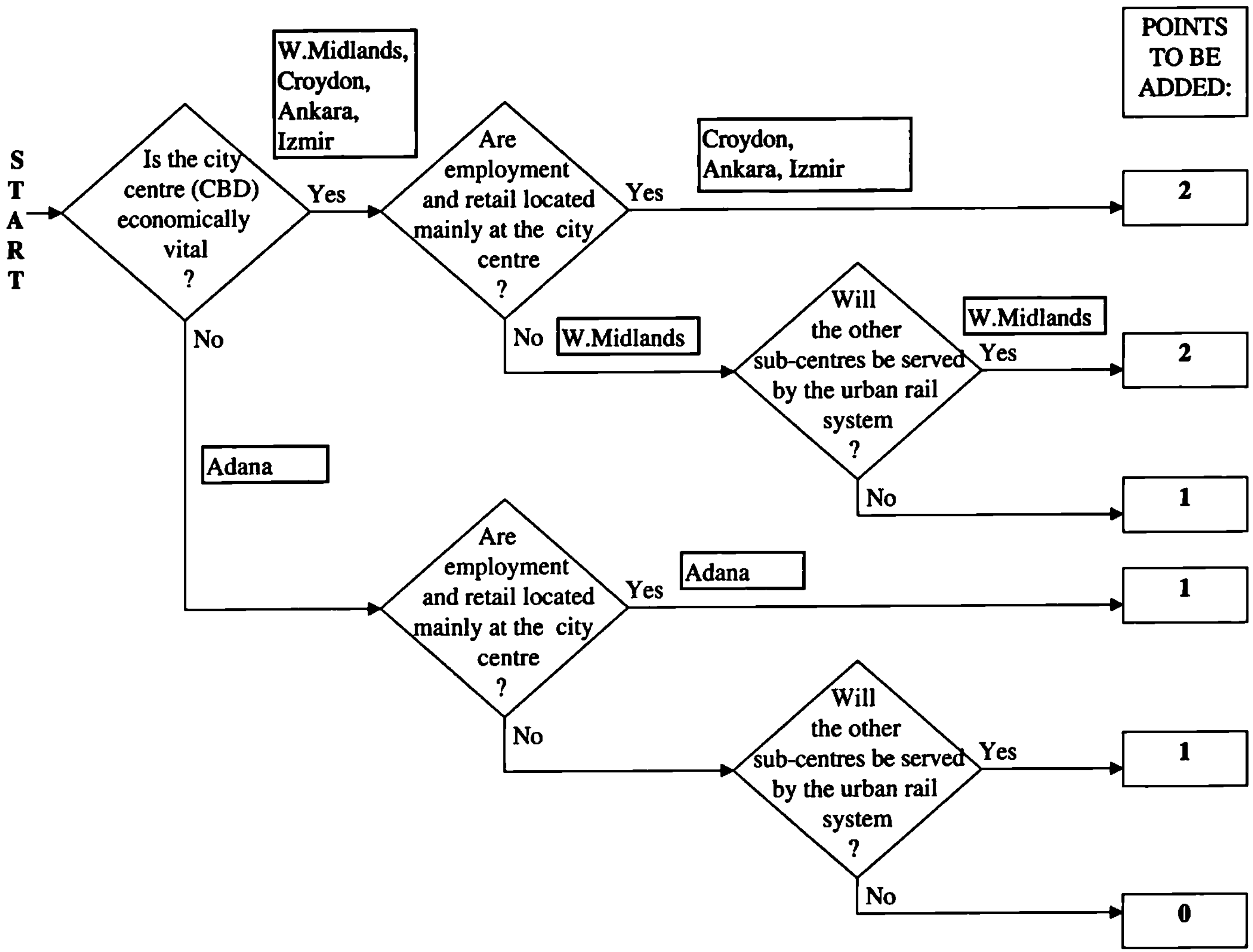


Figure 8.2 **Application of the framework to the new British and Turkish systems: Urban Form**

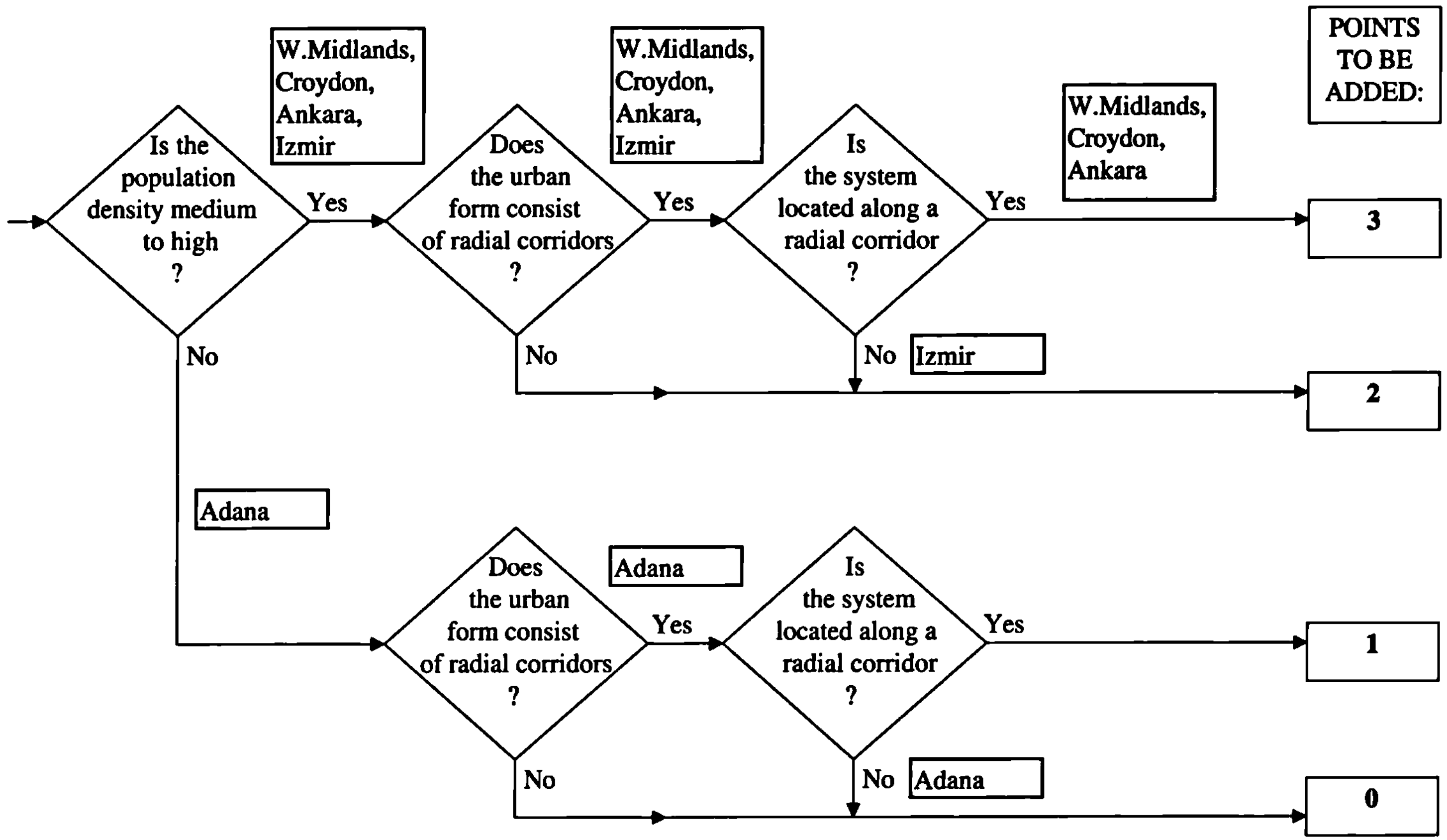


Figure 8.3 Application of the framework to the new British and Turkish systems: Public Transport

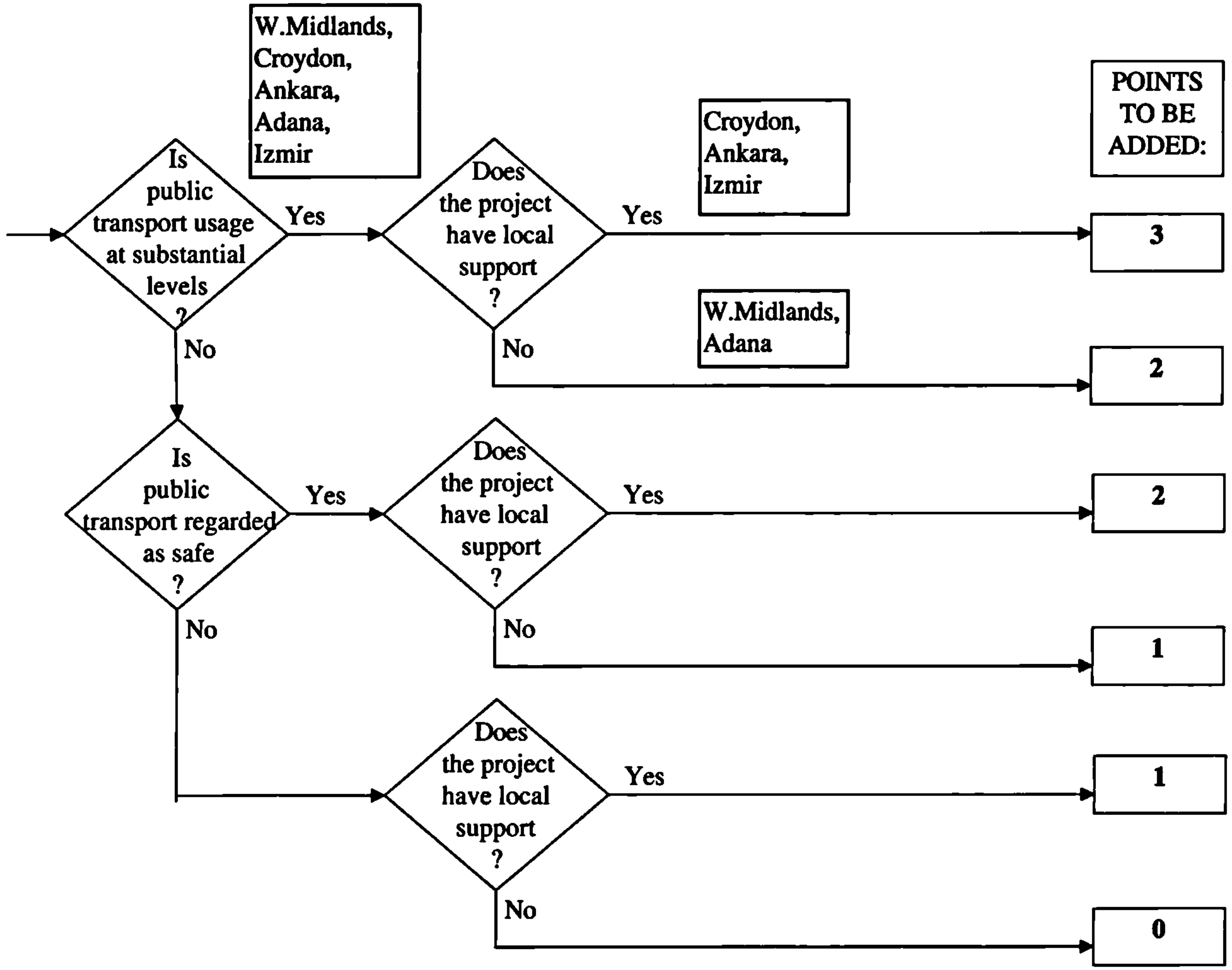


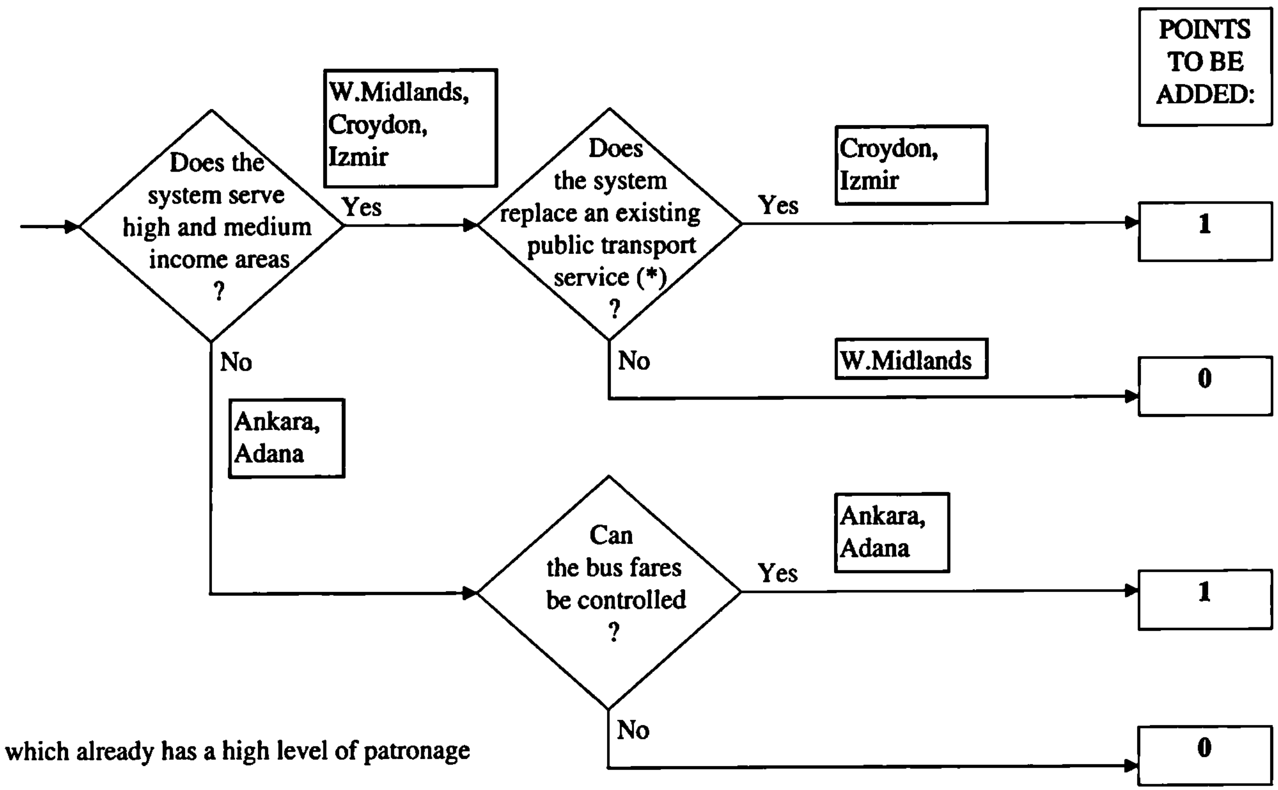
Figure 8.4 shows the income levels of the citizens served. Both systems serve a combination of different income groups; hence, medium and high income groups are among the target population of the systems. Croydon Tramlink replaces bus and rail services with a substantial level of patronage; hence, it scores 1 point. Midland Metro, however, is located along a track of a railway where service ceased long before the development of the system. There is a rail service running parallel; however, this did not cease with the opening of the system. As a result, because it does not replace a public transport system with an already existing level of patronage, Midland Metro is not assigned any points.

Factors regarding the location of the systems are shown in Figure 8.5. The corridors served by Croydon Tramlink are mostly well developed; however, there are some declining areas. It was reported that the system and its location was based on an urban development plan; therefore, the system gains 1 point. Midland Metro is partially located in developed areas; however, there are also under-developed and vacant land along the line. Some of these areas are declining. Because the system was based on an urban development plan, it is recognised that it will be supported by urban plans and policies; hence, the system gains 1 point.

Factors regarding the cost of design are shown in Figure 8.6. Both systems are inexpensive light rail systems; therefore, they both score 1 point.

Policies implemented by the systems are analysed in Tables 8.2 and 8.3. Because the systems have opened very recently, policies that are planned to be introduced are also shown in the tables. Policies are grouped into three categories: policies that have been implemented, policies that it is planned to implement; and policies that have been implemented but have not been very successful, or very supportive of the system. It may be still very early to analyse the effects of policies; however, planners and operators were asked, for some particular policies such as urban renewal or city centre regeneration, whether the integration of the policies and projects with the urban rail system was strong. The policies are included in the category of ineffective policies if planners indicated that integration of projects was poor.

Figure 8.4 **Application of the framework to the new British and Turkish systems: Income Levels**



(*) which already has a high level of patronage

Figure 8.5 Application of the framework to the new British and Turkish systems: Route Location

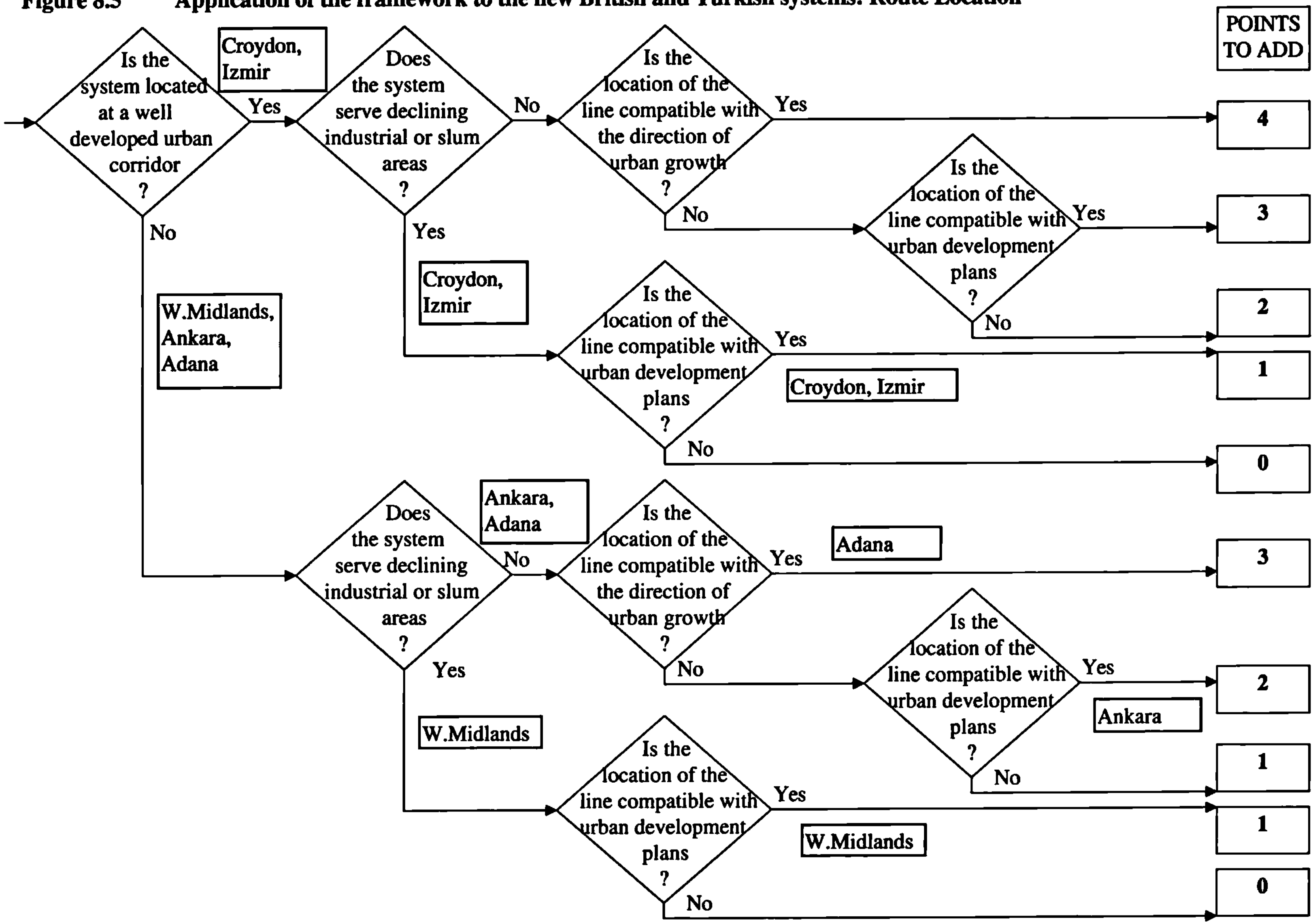
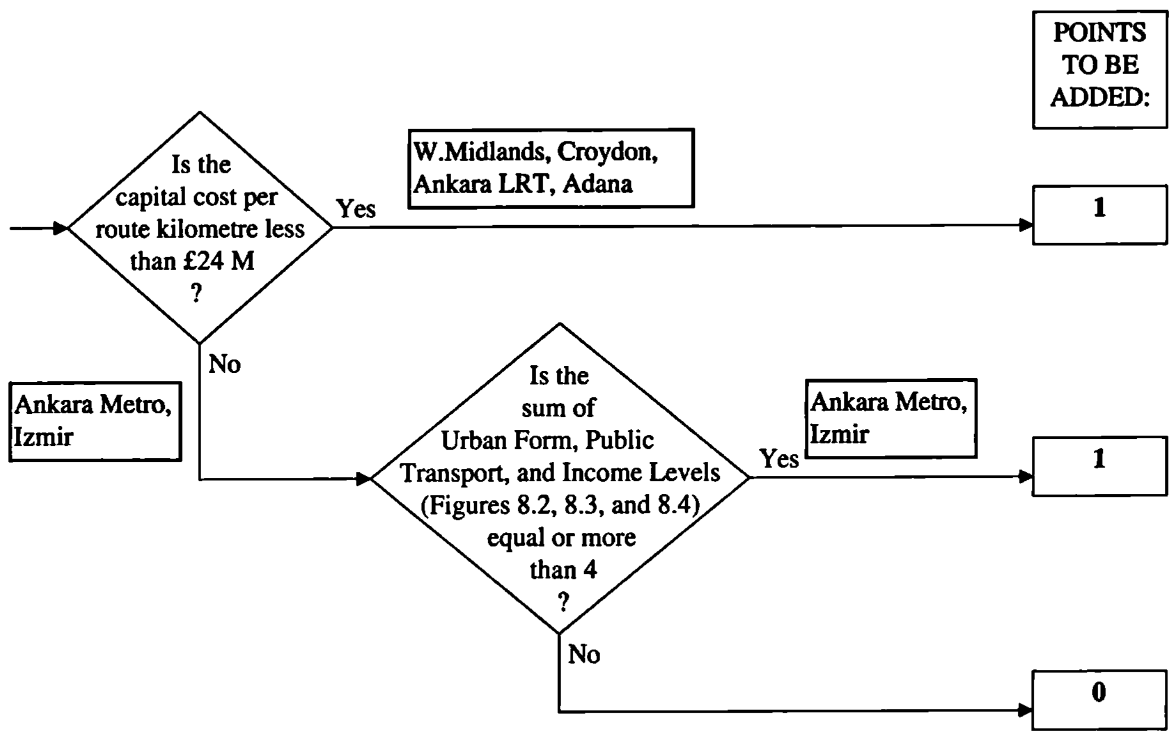


Figure 8.6 Application of the framework to the new British and Turkish systems: Cost of Design



Operating policies are shown in Table 8.2. Two of them have been implemented for Midland Metro: travelcards were introduced, and several actions were taken to market and advertise the system. In Croydon, in addition to travelcards and marketing, free transfers are provided to some bus services that feed into the tram. Concessionary fares on the system are free, but this is not included here since it does not target all customers.

Table 8.2 Operating policies implemented for Midland Metro and Croydon Tramlink

	Providing frequent service	Introducing travelcards	Offering free transfer to buses	Offering free travel	Marketing and advertising	Providing security staff on board and at stations
Midland Metro		●			●	
Croydon Tramlink		●	●		●	

Key: ● The policy has been implemented.

Transport and urban planning policies which have been implemented are shown in Table 8.3. Data provided by planners show that more policies have been implemented in Croydon than in the West Midlands. The system in Croydon was integrated strongly with the city centre regeneration project; stations were located at trip attracting and generating activity centres; buses were reorganised and integrated with the system since they are regulated in London; joint development projects were implemented; new developments were located at system stations; some streets were pedestrianised; and urban renewal projects were implemented. In the West Midlands, buses were reorganised and integrated with the system since the operator of the light rail is the dominant bus operator in the city; car parks were provided at some stations; joint development projects and city centre redevelopment projects were implemented. There are plans to change local plans and rezone some areas to support the system. It is planned to implement some transit oriented development schemes. There also has been an urban renewal project by the Black Country Development Agency. However, it was reported that the project was not public-transport friendly, and that the area was developed as low density warehousing (Hughes, 2000).

The results of the planning framework, which are shown in Table 8.4, indicate that Croydon Tramlink is likely to be a very successful system. It scored slightly less than Vancouver SkyTrain, the most successful case study system, and as high as Portland MAX and Rouen tram which have been observed to be very successful. On the other hand, it must be remembered that policies listed have only been implemented very

Table 8.3 Transport and urban planning policies implemented for Midland Metro and Croydon Tramlink

	Transport planning policies						Urban planning policies						
	Integrating system into regional planning	Integrating system into existing urban projects	Locating stations at trip attractors or generators	Integrating bus services with new system	Providing car parking at stations	Restricting car parks in the city or in the CBD	Adapting plans to the new system, ie rezoning	Incentives of transit-oriented development	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre redevelopment projects / actions	Urban renewal projects
Midland Metro				●	●		O	O	●			●	⊗
Croydon Tram		●	●	●					●	●	●	(1)	●

Key: ● The policy has been implemented.
O It is planned to implement the policy.
⊗ The policy has been implemented; however, it has either not been successful or not been well integrated with the urban rail system.

Note: (1) This is a project that the system was integrated into (the second transport planning policy); therefore, it is not shown under urban planning policies to avoid double-counting.

recently, and their effects are not certain yet. Nevertheless, they may be expected to be effective because the factors regarding urban form and public transport, which have been illustrated in Figures 8.2, 8.3, and 8.4, are very supportive of the system.

Table 8.4 Outcome of the planning framework: total points assigned

	CBD	Urban Form	Public Transport	Income levels	Route Location	Cost of Design	Operating Policies	Supporting Policies	Total (out of 33)
Midland Metro	2	3	2	0	1	1	2	4	**15**
Croydon Tramlink	2	3	3	1	1	1	3	7	**21**

Midland Metro is estimated to be less successful than the tram in Croydon; however, it is predicted to be as successful as the systems in St Louis, San Diego, and Manchester, which are regarded as successful systems. It has been observed that the factors regarding its urban form and public transport usage are in favour of the system in general. However, its low local support, its location in under-developed and declining areas, and the fact that it does not replace an already operating public transport system as in Croydon may influence the effectiveness of some policies and consequently the success of the system.

8.2.2 Recommendations to enhance success

All operating and supporting policies in general are likely to enhance the success of urban rail systems; however, it will be remembered from the discussions in Chapter 6 that some policies are particularly important for cities where the external factors or route locations are not very suitable for an urban rail system. The list of outcomes, for which implementing some of the policies may be important, were presented in Chapter 6 in Tables 6.15 and 6.16.

There are three factors for the Midland Metro that need to be addressed by supporting policies. Firstly, the local support for the project is low. Secondly, the system serves a corridor where good patronage is not ensured because the system does not replace any existing public transport services. Thirdly, the location of routes indicates that the success of the system may be affected because of declining areas along the route. In addition to these factors, buses are deregulated; however, because the operator of buses is also the operator of the system, they are well integrated with each other, and competition is unlikely. Hence, this factor does not seem to affect success.

Table 8.5 shows the policies that can help enhance the success of Midland Metro. The last column summarises the recommended policies. Some of them may already have been implemented. Those which have not been implemented are shown in shaded cells. These are the main recommendations of the framework.

Local support for Midland Metro project was low, and the line does not have an already existing patronage that it can take over. Furthermore, there is a commuter rail service parallel to the system, which may be more attractive for certain journeys because it has fewer stops, and hence it is faster. Therefore, it is very important to make the system as attractive as possible, and operating policies, such as high frequency service, free transfers to buses, and free travel at certain times of the day, can help attract passengers to the system. Because the corridor served by the Midland Metro is only partially developed, and because there are declining areas along the system, it is also important to implement urban planning policies to improve and develop the areas in a public-transport-friendly way. This includes zoning such areas for trip attracting and generating activities and high density residential areas, offering certain incentives to private developers to locate along the system, and locating or relocating public offices at stations which can help to develop the corridor and contribute to the patronage on the system. For these policies to be successful in declining areas, such areas need to be regenerated or redeveloped by the municipalities through an urban renewal project. It was reported that one such project existed, but was not very supportive of the system. Urban renewal projects that are well integrated with the Metro should be implemented.

It was also discussed in Chapter 6 that if personal safety is an important issue in an urban area, a fully segregated system may have an image of being isolated. As mentioned earlier, public transport modes in the West Midlands were reported to be considered unsafe by local people. Midland Metro uses a former mainline rail route; therefore, it is segregated from traffic except a two kilometre street running section. As a result, it may be necessary to enhance the safety image: providing security staff on board or at stations can help the system.

Table 8.5 Policy recommendations for Midland Metro

	Providing frequent service	Offering free transfers to buses	Travel-cards	Offering free travel	Marketing and advertising	Providing security staff	Integrating system into regional planning	Integrating system into urban projects	Locating stations at trip attracters	Integrating buses with the new system	Providing car parks at stations	Adapting plans to the new system	TOD incentives	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre re-development projects	Urban renewal projects
Public transport usage is low (1)	✓	✓	✓	✓	✓	✓												
System serves high income levels	✓			✓							✓							
System serves declining areas							✓	✓				✓	✓	✓	✓			✓
Result: recommended policies	✓	✓	✓	✓	✓	✓	(2)	(2)			✓	✓	✓	✓	✓			✓

Each tick indicates that the framework advices the corresponding policy to be impelemented as a measure to enhance success.

The last row summarises the policies: if the policies are recommended at least once, they are shown in the last row. Some of the recommended policies have already been implemented. Shaded cells shows the policies that have not been implemented, and therefore they are the principle recommendations of the framework.

(1) If local support for the project is low, these policies should be considered regardless of the ourcome of the Public Transport factors.

(2) These policies are not valid at this stage: the system is already planned and developed.

Table 8.6 shows the policies recommended to enhance the success of Croydon Tramlink. There is only one factor for the tram which may affect its success: factors regarding the location of its routes indicate that there are declining areas along the system. It would help if these areas were redeveloped. It was reported that renewal projects were already being implemented. Joint development projects were also implemented, and new development were located at station sites. In addition to them, rezoning the declining areas to develop them as trip attracting urban activities, and offering incentives to developers to locate in such areas can help the development of these sites, and eventually help the patronage of the system.

As discussed in Chapter 6, a high proportion of street-running segments or too frequent stops may have disadvantages if signalling priority is not in favour of the urban rail system. They may severely hinder success, particularly if there is competition from buses. 11 km of the Tramlink is on streets, and the average distance between stops is 0.73 km, which is one of the lowest observed in this study. However, it was reported that signalling in mixed traffic will be in favour of the tram. Besides, there is no competition from buses since they are regulated in London. Therefore, it is believed that the street running segments and frequent stops will not make the system less reliable, and so hinder its success, as experienced in Sheffield.

8.3 NEW URBAN RAIL SYSTEMS IN TURKEY

There has been intense investment in urban rail systems, particularly light rail systems, in the recent years in Turkish metropolitan cities. A light rail system and a tram started to operate in Istanbul in 1988 and 1992, respectively. Another system, a metro is currently being constructed. In Ankara, a light rail system and a metro opened in 1996 and 1997, respectively. A small light rail system opened in Antalya in 1999. Izmir, the third biggest city in Turkey, has started operating a light rail system in 2000. There are light rail systems that are under construction in Adana and Bursa.

Operators and planners of these systems, and researchers in universities in Turkey have been contacted, and information was obtained for the systems in Ankara, Adana and Izmir (Table 8.7). The following sections present the analysis of the planning of these

Table 8.6 Policy recommendations for Croydon Tramlink

	Providing frequent service	Offering free transfers to buses	Travel-cards	Offering free travel	Marketting and advertising	Providing security staff	Integrating system into regional planning	Integrating system into urban projects	Locating stations at trip attracters	Integrating buses with the new system	Providing car parks at stations	Adapting plans to the new system	TOD incentives	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre re-development projects	Urban renewal projects
System serves declining areas							✓	✓				✓	✓	✓	✓			✓
Result: recommended policies							(1)	(1)				✓	✓	✓	✓			✓

Each tick indicates that the framework advices the corresponding policy to be impelemented as a measure to enhance success.
The last row summarises the policies: if the policies are recommended at least once, they are shown in the last row. Some of the recommended policies have already been implemented. Shaded cells shows the policies that have not been implemented, and therefore they are the principle recommendations of the framework.
(1) These policies are not valid at this stage: the system is already planned and developed.

systems. Their success are predicted, and recommendations are made to help enhance their success.

Table 8.7 New Turkish urban rail systems to which the planning framework is being applied

City	Name of system	Type of system	Opening year	Length (km)
Ankara	Ankara Metro	metro	1997	14.7
	Ankaray	light rail system	1996	8.5
Adana	Adana Light Rail	light rail system	under construction	13.3
Izmir	Izmir Light Rail	light rail system	2000	11.6

8.3.1 Predicting success

The planning framework has been applied to the three Turkish urban rail systems in order to predict how successful they will be. Figures 8.1 to 8.6 present the application of the External and Planning Factors.

As shown in Figure 8.1, Ankara and Izmir have economically strong CBDs while the Adana CBD has been reported not to be very strong economically. Decentralisation is a common process for all cities; however, their CBDs remain as an important centre for employment and retail activities. As a result, Ankara and Izmir gain 2 points, and Adana gains 1 point.

The population densities are high in Ankara and Izmir while Adana has a low population density (Figure 8.2). It was reported that the city has some radial corridors along which the city had grown, but that the system was not located in one of them. Hence, Adana does not gain any points in this diagram. Ankara and Izmir contain radial corridors. Ankara metro and light rail systems are located along such radial corridors, but this is not the case in Izmir: the system is located in central Izmir. As a result, Izmir gains 2 points while Ankara gains 3 points.

Factors regarding public transport in the three Turkish cities can be seen in Figure 8.3. Public transport usage is high in all three cities. The projects in Izmir and Ankara had high local support, but it has been reported for Adana that the local support for the project was low. Hence, Adana gains 2 points while Ankara and Izmir gain 3 points.

The systems in Ankara and Adana serve medium and low income areas, as shown in Figure 8.4. Because bus fares are controlled by the public agencies that provide transport services, these systems gain 1 point. The system in Izmir serves a combination of different income groups. It was reported by the planners that the system replaced a well used bus route; therefore, it is also assigned 1 point.

Figure 8.5 shows the factors regarding the location of the systems. The system in Izmir is located along a well developed corridor while those in Ankara and Adana are partially in under-developed areas. The latter two do not serve any declining old industrial sites. Adana LRT is located in areas favoured by the natural direction of urban growth: it gains 3 points. The systems in Ankara are not located in areas that urban growth trends favour; however, they are located in areas supported by the urban plans. Hence, they gain 2 points. The system in Izmir partially serves declining areas. It is based on a metropolitan plan, and is compatible with urban plans: it gains 1 point.

As seen in Figure 8.6, the light rail systems in Ankara and Adana cost less than £24 million per their route kilometre. In fact, compared to many light rail systems, the Ankara Light Rail is a very expensive system, probably because it is predominantly underground. It cost £20.5 million per route kilometre (EGO, 2000). Nevertheless, it is lower than £24 million, which is the average of all urban rail systems in North America and Europe, and therefore it gains 1 point. So does the light rail system in Adana. The metro in Ankara and the light rail system in Izmir cost more than £24 million per kilometre; however, the systems gained high points from Urban Form, Public Transport, and Income Levels parts of the framework. Hence, high cost investment is justified, and they are assigned 1 point.

The operating policies of the systems are shown in Table 8.8. For the light rail system in Adana, which is not operational yet, the operating policies have not been finalised; therefore, there is no data on how the system will be operated. For the systems in Ankara and Izmir, data is available. In Ankara, most policies have been implemented, and there are plans to take actions for marketing and advertising the system. In Izmir, 3 policies have been implemented so far, and there are plans to offer free transfers to buses and provide additional staff on board and at stations for personal security.

Table 8.8 Operating policies implemented in Ankara, Adana, and Izmir

	Providing frequent service	Introducing travelcards	Offering free transfer to buses	Offering free travel	Marketing and advertising	Providing security staff on board and at stations
Ankara Metro and LRT	●	●	●			●
Adana LRT (1)						
Izmir LRT	●	●	O		●	O

Key: ● The policy has been implemented.
O It is planned to implement the policy.
(1) The system is still under construction: operating policies have not been decided yet.

Supporting policies implemented in the three cities are shown in Table 8.9. The systems in Ankara and Adana are based on, and well integrated with, metropolitan development plans. The system in Adana was also well integrated with other urban projects. It was reported for Izmir, however, that the integration between projects has not been strong, and that there were no signs that metropolitan plans were supportive of the system. In all cities, bus services are, or will be, integrated with the new system, and car parks are provided at some stations. It is remarkable that very few urban planning policies have been implemented in the cities: joint development projects were implemented in Ankara and Adana, and city centre redevelopment and pedestrianisation projects were implemented in Adana, and are planned to be introduced in Izmir, but that is all.

The results of the planning framework are summarised in Table 8.10. The system in Ankara is predicted to be the most successful. The framework indicates that the system may be as successful as Portland MAX and Rouen Tram (see Table 7.12 in Chapter 7). The light rail system in Izmir will also be successful: it is expected to be as successful as the systems in St Louis, San Diego, and Atlanta. It should, however, be remembered that the effects of policies that are very recently implemented cannot be assessed, and this may cause a slight overestimation of success for Izmir light rail. Adana light rail gained 13 points from the framework which is lower than those of the Izmir and Ankara systems; however, it still indicates that the system can be fairly successful. It is estimated to be as successful as Tyne and Wear Metro and Los Angeles Light Rail. In fact, the system can be expected to be more successful because the operating policies have not been decided yet, and so they have not been included in the framework predictions.

Table 8.9 Transport and urban planning policies implemented in Ankara, Adana, and Izmir

	Transport planning policies						Urban planning policies						
	Integrating system into regional planning	Integrating system into existing urban projects	Locating stations at trip attractors or generators	Integrating bus services with new system	Providing car parking at stations	Restricting car parks in the city or in the CBD	Adapting plans to the new system, ie rezoning	Incentives of transit-oriented development	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre redevelopment projects / actions	Urban renewal projects
Ankara	●			●	●				●				
Adana	●	●		○	●				●		●	(1)	
Izmir	⊗	⊗		●	●						○	○	

Key: ● The policy has been implemented.
○ It is planned to implement the policy.
⊗ The policy has been implemented; however, it has either not been successful or not been well integrated with the urban rail system.

Note: (1) This is a project that the system was integrated into (the second transport planning policy); therefore, it is not shown under urban planning policies to avoid double-counting.

Table 8.10 Outcome of the planning framework: total points assigned

Systems in:	CBD	Urban Form	Public Transport	Income levels	Route Location	Cost of Design	Operating Policies	Supporting Policies	Total (out of 33)
Ankara	2	3	3	1	2	1	4	4	**20**
Adana	1	0	2	1	3	1	0	5	**13**
Izmir	2	2	3	1	1	1	3	2	**15**

Among the systems analysed, Ankara metro and light rail are already in operation; therefore, it is possible to compare the estimates with the actual performance of the system. Some indicators of patronage and financial performance are presented in Table 8.11.

Table 8.11 Performance indicators of the metro and LRT in Ankara

	Ankara Metro	Ankaray (LRT)	Average of case and test systems
Passengers / route km	4,451,304	5,903,926	597,243
Passengers / vehicle km	20	17	3
Annualised capital cost / passenger	£0.49	£0.29	£2.89
Operating cost / passenger	£0.05	£0.04	£0.98
Passenger / staff	103,046	98,981	57,467

In both patronage and financial terms, the system appears very successful. On the other hand, it should be remembered that the system appears successful compared to the average of the systems in the United States, Canada, and Britain. Public transport usage in these countries is much lower than that in Turkey. For example, annual public transport trips per person in Ankara is 248 for the year 1998. It will be remembered from Chapter 4, Table 4.3, that annual number of public transport trips per person was 179 in Tyne and Wear, 126 in Vancouver, and as low as 19 in the Californian city Sacramento. As a result, the high patronage values of the system in Ankara should be considered within the framework of high public transport usage in Turkey; nevertheless, the analysis indicates the system to be successful.

In Table 8.12, the overall performance of the Ankara system is summarised. Analysis is not separated between the metro and LRT since the overall performance of the two systems is very similar. The number of passengers per route kilometre and passengers per vehicle kilometre are very high, and therefore the system is regarded as fulfilling the criteria. The forecast patronage, on the other hand, was much higher than the actual patronage of the systems. The system, therefore, fulfils two patronage criteria, out of three. In terms of financial performance, all indicators show that the system was very efficient to build, and it is very efficient to operate. It fulfils all three criteria. The system has been reported to have positive effects on total public transport usage. The modal share of public transport did not change; however, the patronage of the system is increasing. Bus patronage in the city did not decrease after the opening of the system; therefore, the system is regarded as satisfying two criteria out of three. There have been slight impacts on car usage, traffic congestion and environmental quality along the corridors of the system; however, the operator and planner of the system reported that such impacts were insignificant. As for land-use impacts, it was reported that the city centre had benefited from the investment, and the density of developments along the rail system has increased. As a result, the system satisfies 9 criteria out of 14 (revitalisation of declining areas is not applicable).

Table 8.12 The overall success of the metro and LRT in Ankara

System in:	To attain a high patronage	To operate cost-effectively	To increase public transport usage	To prevent/solve car traffic and associated environment problems	Land-use and development related objectives	Total number of ticks
Ankara	✓✓	✓✓✓	✓✓		✓✓	9

When the framework estimate is compared with the observed performance of the system, the estimate appears accurate. The system scored 20 points from the framework, only 1 point less than Portland MAX and Rouen Tram, indicating that its success can be expected to be similar to theirs. It was indeed observed to be equally successful as the systems in Portland and Rouen, which also satisfied 9 criteria.

8.3.2 Recommendations to enhance success

It has been observed that very few urban planning policies have been implemented in the Turkish cities. It can be suggested that implementation of these policies, in general, would help the success of the systems. In addition, following the recommendations that were made in Chapter 6, and summarised in Tables 6.15 and 6.16, there are certain conditions for which some policies should be given priority.

There are three conditions in Adana that may affect the success of the system: the CBD is not very strong; the urban form is not very suitable; and local support for the project is low. These conditions can be addressed by some policies, as shown in Table 8.13.

The framework proposes some urban planning policies to encourage development in the CBD in Adana. It was reported that some joint development projects, and city centre redevelopment and pedestrianisation projects have already been implemented. In addition to them, transit-oriented development incentives, such as tax reductions, development bonuses, and reductions in car parking requirements, may attract developers to the CBD. Locating new public buildings and developments at station sites can also help revitalise the CBD. These policies can also help develop the corridor, and increase densities. Urban planning policies would enhance success in the long-term. In the short-term, operating policies which can help provide a high standard of service may enhance the success of the system. The problem about the low local support for the project can also be tackled by the operating policies. These can help increase the attraction of the system, and help overcome negative perceptions of the citizens.

There is one condition in Izmir, which may affect the success of the light rail system (Table 8.14). It was reported that the system partially serves declining areas. Redevelopment of these areas would enhance the success of the system. Urban renewal projects, rezoning the areas for trip attracting and generating activities, and offering incentives to developers to locate in these areas can help improve and redevelop such declining areas.

For Ankara, most of the factors analysed have been found suitable for urban rail investment. Therefore, the framework does not recommend a particular policy. However, it was observed that very few urban planning policies have been implemented in Ankara to support the urban rail systems. It can be concluded that implementation of more urban planning policies in integration with the rail systems, can help enhance the success of these systems.

Table 8.13 Policy recommendations for the light rail system in Adana

	Providing frequent service	Offering free transfers to buses	Travel-cards	Offering free travel	Marketting and advertising	Providing security staff	Integrating system into regional planning	Integrating system into urban projects	Locating stations at trip attracters	Integrating buses with the new system	Providing car parks at stations	Adapting plans to the new system	TOD incentives	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre re-development projects	Urban renewal projects
The CBD is not vital economically													✓	✓	✓	✓	✓	
The urban form is not suitable	✓	✓	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓			
Public transport usage is low (1)	✓	✓	✓	✓	✓	✓												
Result: recommended policies	✓	✓	✓	✓	✓	✓	(2)	(2)			✓	✓	✓	✓	✓	✓	✓	

Each tick indicates that the framework advices the corresponding policy to be impelemented as a measure to enhance success.
The last row summarises the policies: if the policies are recommended at least once, they are shown in the last row. Some of the recommended policies have already been implemented. Shaded cells shows the policies that have not been implemented, and therefore they are the principle recommendations of the framework.
(1) If local support for the project is low, these policies should be considered regardless of the ourcome of the Public Transport factors.
(2) These policies are not valid at this stage: the system is already planned and developed.

Table 8.14 Policy recommendations for the light rail system in Izmir

	Providing frequent service	Offering free transfers to buses	Travel-cards	Offering free travel	Marketing and advertising	Providing security staff	Integrating system into regional planning	Integrating system into urban projects	Locating stations at trip attracters	Integrating buses with the new system	Providing car parks at stations	Adapting plans to the new system	TOD incentives	Joint development projects	Locating public development at stations	Pedestrianizing streets	City centre re-development projects	Urban renewal projects
System serves declining areas							✓	✓				✓	✓	✓	✓			✓
Result: recommended policies							(1)	(1)				✓	✓	✓	✓			✓

Each tick indicates that the framework advices the corresponding policy to be impelemented as a measure to enhance success.
The last row summarises the policies: if the policies are recommended at least once, they are shown in the last row. Some of the recommended policies have already been implemented. Shaded cells shows the policies that have not been implemented, and therefore they are the principle recommendations of the framework.
(1) These policies are not valid at this stage: the system is already planned and developed.

In addition to the policies listed, it was discussed in Chapter 6 that some additional policies may be required if public transport modes are not considered safe, or if systems are not segregated from traffic, have low stop spacing, and are subject to bus competition. None of the conditions apply to the Turkish urban rail systems.

8.4 CONCLUSION

The planning framework has been demonstrated on two British and three Turkish urban rail systems. The success of these systems has been predicted, and recommendations have been made to enhance their success.

Among the new British systems, it has been observed that Croydon Tramlink will be a very successful system. The planning framework has revealed that its success can be enhanced further if certain urban planning policies are implemented to develop and improve declining areas along the system. Midland Metro has been predicted to be less successful than Croydon Tramlink although it is likely to be as successful as the Manchester Metrolink. It has been observed that low local support for the system, the poor image of public transport systems in terms of personal safety, the location of the system in some under-developed and declining areas, and the fact that it does not replace an existing public transport service may hinder success to some extent. Several policies have been recommended to overcome the possible effects of these factors.

Among the new Turkish systems, the metro and light rail systems in Ankara have been predicted to be the most successful. Analysis of the actual performance of these systems has verified the prediction of the framework. The light rail systems in Adana and Izmir have been predicted to be less successful than those in Ankara. Urban planning policies have been recommended for the system in Adana in order to improve the conditions regarding the CBD and urban form. In addition, operating policies have been recommended to improve the image of the system which has low local support. For the system in Izmir, which is partially located in declining areas, urban planning policies have been recommended.

It has been observed that very few urban planning policies have been implemented in the Turkish cities. It appears that, like their British counterparts, the Turkish local authorities are not very experienced with some of the urban planning policies, such as incentives of transit-oriented development and joint development. It may be argued that because Turkish cities are higher in density than British, Canadian and particularly American cities, transit-oriented-development policies may not be as necessary. On the other hand, not all urban rail systems are located in well-developed areas. Hence, attracting new development along the systems is an important tool for enhancing the success of the systems. As a result, Turkish local authorities can learn some lessons from the experiences of their North American counterparts with urban planning policies that are aimed at attracting developers along urban rail corridors.

9. CONCLUSIONS

9.1 SUMMARY OF THE RESEARCH

This research has been aimed at developing a better understanding of the factors that influence the success of urban rail systems. The principle aim has been to develop a methodology for measuring, and identifying the factors behind, success, and to develop a planning framework which can help enhance the success of new metros and light rail systems. The framework can help planners to develop successful systems, as well as increase the success of existing ones. In addition, special emphasis has been placed on alternative mechanisms of providing and sustaining co-ordination between transport and urban planning, which does not seem to exist spontaneously within many existing local government structures.

The planning framework has been developed based on the analysis of eight urban rail systems: Miami Metrorail, St Louis MetroLink, San Diego Trolley, and Sacramento LRT in the United States; Vancouver SkyTrain in Canada; Tyne and Wear Metro, Manchester Metrolink, and Sheffield Supertram in Britain. The analysis of these systems has been carried out in two stages. First, the planning background and factors regarding the operation of the systems were observed. Second, the success of the systems was analysed. In the analysis, possible links between success and background factors have been established. These links have been used as the basis for developing the planning framework which has two main functions: to predict how successful a new urban rail system will be, and to make recommendations on how its success can be enhanced.

Because the planning framework is based on the analysis of eight case studies, it was important to validate it against other urban rail systems. The framework has been validated against nine systems: Atlanta Metro, Baltimore Metro, Baltimore LRT, Los Angeles Metro, Los Angeles LRT, Portland MAX, and San Jose LRT in the United States; Calgary C-Train in Canada; and Rouen tram in France.

Finally, the framework has been applied to urban rail systems that have recently opened for service in Britain and Turkey. The framework has shown how successful these systems will be, and how their success can be enhanced.

9.2 THE EXTENT TO WHICH THE OBJECTIVES OF THE RESEARCH HAVE BEEN MET

The main aim of this research was to develop a methodology for measuring success, analysing and identifying the factors behind it, and, finally, help make urban rail systems more successful. Within this main aim, the objectives of the research, as discussed in Chapter 3, were as follows:

- To provide a better understanding of the factors that make urban rail systems successful.

- To explore alternative ways of providing and sustaining co-ordination between transport and urban planning.

- To establish mechanisms for influencing the factors that affect the success of urban rail systems with the underlying purpose of making them more successful.

- To design a planning framework which can help urban rail planners and operators to maximise the success of their systems, and enhance the co-ordination between transport and urban planning.

- To demonstrate the validity of the planning framework.

- To apply the framework to new British and Turkish urban rail systems, and identify ways in which the urban rail planning process in these countries can be improved.

These objectives have been met in the study. The findings of the analysis have met the first objective by establishing a better understanding of the factors that affect the success of urban rail systems. These factors are described in more detail in the next section, when the main findings of the research are discussed.

The second objective has also been met: the analysis revealed that policy co-ordination could be achieved even in local government settings that do not appear to be appropriate for a co-ordinated planning. This issue is also discussed below, in the next section.

The third and fourth objectives have been met by the development of the planning framework which can help control the factors that affect the success of urban rail systems, and which can provide recommendations on how success can be enhanced, and how co-ordination between transport and urban planning can be reinforced. The development of the framework have also helped to fulfil the principal aim of this study: to develop a methodology that would help enhance the success of urban rail systems.

The fifth objective was met by the validation of the framework against urban rail systems that have not been studied in the case study analysis.

The sixth objective has also been met: the framework has been applied to Midland Metro and Croydon Tramlink in Britain, and to Ankara Metro and LRT, Adana LRT, and Izmir LRT in Turkey. The framework predicted the success of these new systems, and provided recommendations on how their success can be enhanced.

9.3 FINDINGS OF THE RESEARCH

9.3.1 Success analysis of the urban rail systems

The analysis which was carried out in Chapter 5 showed that, of the eight systems analysed there, Vancouver SkyTrain in Canada was the most successful, followed by the light rail systems in St Louis and San Diego from the United States. Manchester Metrolink and Tyne and Wear Metro in Britain were also successful systems while the light rail systems in Sheffield, in Britain, and Sacramento, in the US were unsuccessful. Miami Metrorail in the US was observed to be the least successful system.

The success of Vancouver SkyTrain was to some extent associated with urban form and socio-economic factors: population density and public transport usage levels were fairly high. In addition, supporting planning actions contributed significantly to the success of the system. During the construction of the system, municipalities redeveloped old industrial areas that the system was located through, and channelled most of their investment to develop the corridor. Local plans were adapted to the system; stations areas were rezoned; development bonuses were offered to private developers; joint development schemes were implemented; and some government buildings were relocated at SkyTrain stations. The strong support of the municipalities was a consequence of the strong integration of the SkyTrain plans into the local plans and projects of the municipalities. In addition to the strong support of the municipalities, other factors, such as the high frequency of service, and the reorganisation of buses to feed into the system, may also have contributed to the high patronage.

Factors behind the success of St Louis MetroLink were the existence of a radial corridor which the system was located along, new public developments located at the light rail stations, some urban renewal schemes in the city centre, integration of buses with the light rail system which included a radical improvement of bus services, and operating policies including free light rail journeys in the city centre at off-peak times and additional security staff on board and at stations. Although the system is regarded successful, there are few factors which may have limited its success. Most of the stations outside the city centre accommodated surface car parks, and therefore may have hindered development at station sites. In addition, the lack of an effective and comprehensive city centre redevelopment plan may have decreased the success of the system since the city centre is declining.

In San Diego, the location of the first line was an important reason for the system's success since the corridor had the highest level of public transport usage. In addition, the integration of the buses with light rail, the city centre redevelopment project with which planning of the Trolley was co-ordinated, and the transit-oriented-development schemes of the municipalities, have been effective in increasing development densities and improving the urban environment along the system. On the other hand, not all the municipalities were eager to adapt their plans to the Trolley. There were vacant and declining areas along the Trolley which did not receive any investment from the municipalities.

For Manchester Metrolink too, the location of the lines was an important factor. The system replaced commuter rail services which already had a substantial level of patronage. The reason that the light rail has been more successful than the former commuter lines was because it provided a city centre rail link, and had a high service frequency. Renewal of some city centre buildings and the pedestrianisation of a city centre street have also contributed to the success of the system. In addition, the urban form of the city, with its high population density and radial corridors, was also suitable. On the other hand, high fares and bus deregulation, which prevented the integration of the system with buses, may have limited the success of the system. In addition, support from the municipalities to invest at, and develop, the Metrolink stations were very limited.

The high population densities and high levels of public transport usage in Tyne and Wear, were among the main factors behind the success of the metro there. Besides, the system is very extensive, and serves the majority of town centres. The city centre redevelopment project in the early 1980s has also contributed to the effectiveness of the system, since redevelopment areas were well integrated with the metro stations. In addition, the system was very well integrated with buses when it opened for service although integration was lost after the deregulation of buses in 1985. The current decline in the patronage of the metro may be attributed to the loss of integration with buses as well as to recent investments, such as the Metro Shopping Centre built in an Enterprise Zone and the new office developments within the Tyne and Wear Development Corporation project. These developments and projects were not very supportive of the Metro, nor are the existing development plans of the municipalities.

Among the systems that are regarded as unsuccessful, Miami Metrorail was the least successful one. The main reason for failure was the unsuitable urban form, the low density of development, and the small and economically weak CBD. In addition, financial problems prevented the buses from being improved and service levels from being increased. Car restriction schemes were also planned but not introduced. Another problem in Miami was the public relations which were poorly handled: citizens who opposed the investment vandalised the system. In addition to these factors, the technology of the system was not suitable for the city: high cost investment was not suitable for the extremely low density urban area. Besides, the city centre part of the Metrorail, the Metromover, is an automatic system, and operating trains without any metro staff on board was not suitable for an urban area where crime and personal safety were important issues. In spite of all the factors that hindered the success of the system, joint development schemes contributed towards increasing the development densities in the corridor. Nevertheless, their effects remained negligible.

The most important factors that hindered success in Sacramento were the very low density urban form and the high income profile of the citizens. In spite of the efforts of planners to increase densities along the system by introducing development bonuses or tax incentives, private developers did not co-operate, because there was no market for high density housing in the city. The location of the routes also had some negative effects on the success of the system: there are very few attractions along the line, which can generate or attract trips. In addition, financial problems had prevented the improvement of buses and their integration with the light rail system in initial years of operation. The frequency of the trains also remained poor as a result of financial problems. There were some positive factors: the pedestrianisation of a city centre street where the light rail system runs, improvement of integration with buses, and free transfers between buses and the LRT.

There were several factors which hindered success in Sheffield. The system served low income neighbourhoods, and the planners who were interviewed argued that those with low incomes should not be the target population of light rail. In addition, the CBD was very weak, and therefore it was not a trip attracting or generating centre. There were also some design and planning issues. The system is mostly street running, and it had rather poor signalling priority in traffic, which resulted in its being slow and unreliable. This was a particularly important problem because there was competition from buses. Another factor was the alignment of the system: it was designed to serve some high density council flats, which were demolished by the local authority during the construction of the system. One of the lines was planned to help revitalise a declining area which was the subject of a regeneration project led by an Urban Development Corporation. However, the line and the stops were poorly located for serving new activity centres developed within the regeneration project. On the other hand, the performance of the system has improved recently. On-board ticket sales has been introduced by employing additional staff on each tram. This operating policy was introduced to address the problems related to the usage of ticket machines and the fare evasion; however, it helped to improve the image of the system as well, particularly in terms of personal safety. Signalling priority has also been improving.

Among the reference systems, which were used to validate the planning framework, Calgary C-Train in Canada was the most successful one, followed by Portland MAX in the US and Rouen Tramway in France. Atlanta Metro and Los Angeles Light Rail (the Blue Line) were also successful while San Jose was observed to perform poorly. Baltimore Metro and Light Rail and Los Angeles Metro (the Red Line) were the least successful of the reference systems, although performing slightly better than Miami Metrorail. Analysis of these systems has not been made in as much detail as that of the case systems: some of the analysis had to be based on the judgement of the planners and operators of these systems. Nevertheless, some factors appeared as significant for the success. In Calgary, the economic vitality of the CBD, suitable urban form, high levels of public transport usage, and effective operating and supporting policies appeared to be important for the success of the C-Train. In Rouen too, suitable urban form, high levels of public transport usage, and effective operating and supporting policies made the system successful. In Portland and Atlanta, supporting policies, particularly effective land-use policies, were observed to be the main factors behind success. In San Jose, Los Angeles, and Baltimore, unsuitability of the factors regarding urban form and public transport, and the lack of effective policies to support the systems were the reasons behind the limited success of the systems.

9.3.2 Factors behind success

The factors behind the success of the observed systems, which have been summarised above, can be grouped under four headings: external factors, planning factors, operating policies, and supporting policies.

External factors include factors concerning the urban form, socio-economic conditions, and public transport operating regimes. The economic vitality of central business districts (CBDs), the location of employment and retail activities in the city, population density, and the urban pattern were observed to have effects on the performance of urban rail systems. In addition, public transport usage in urban areas, the image of public transport modes in terms of personal safety, and the level of local support for the urban rail project were found to have effects on success. The income levels of the people served by the rail system were also observed to be important. Very high income neighbourhoods were found to be unsuitable for urban rail investment. Low income was not a suitable factor either, particularly in relation to the nature of the public transport regulatory regimes. Deregulation of buses which may inhibit the integration of urban rail systems with buses, as observed in England, was found to have hindered the success of systems to some extent, particularly when the systems serve lower income areas.

Some factors regarding the planning of systems were also observed to be effective. Analysis showed that the way public relations are handled may influence the local support for the urban rail project, and hence affect its patronage. In addition, factors regarding the location of routes, such as their being located in well-developed and economically vital areas, and their being compatible with development plans, were observed to have significant effects on success. Design features, such as technology, segregation, and grade separation, were observed to have limited effects on the success of systems; however, it was also observed that some design attributes were not suitable for certain urban areas.

The analysis showed that operating policies could also be very effective in enhancing the success of urban rail systems. Policies such as providing frequent service, introducing travelcards, offering free transfers to buses, offering free travel on some parts of the system at specific times of the day, marketing and advertising the system, and providing security staff on board, at stations and at car parks, are likely to increase the attraction of urban rail systems, and hence increase their success.

Supporting policies, which are grouped in the study as transport planning policies and urban planning policies, were also observed to be very important for the success of urban rail systems. Transport planning policies, such as integrating the system into regional planning and into existing urban projects, locating stations at trip attractors and generators, integrating bus services with the urban rail system, providing car parks at stations, and implementing car parking restrictions in the city centre, are likely to increase the effectiveness of urban rail systems. Urban planning policies can also be very effective. Policies such as adapting municipal plans to the urban rail system, offering incentives for public-transport-friendly development (transit-oriented development), implementing joint development projects, locating public developments at stations, pedestrianising city centre streets, implementing city centre redevelopment projects, and implementing urban renewal projects along the new urban rail system, have resulted in a more public-transport-friendly environment, and have helped to enhance the success of systems.

The analysis also showed that under certain conditions, some urban planning policies may fail to be effective. It was observed that joint development and transit-oriented-development projects, and tax incentives for attracting developers have failed in some economically depressed areas or areas that contained declining old industrial sites. In such areas, these policies were effective only when accompanied by a comprehensive urban renewal or redevelopment project. In addition to the economic vitality of areas, some urban forms and development patterns were also observed to have prevented the policies being effective. In urban areas that are very car-oriented, policies failed to have any significant effects. In extremely low density areas, developers did not respond to the incentives or joint development opportunities since there was no market for high density and transit-oriented development.

Based on the findings of the analysis as described above, a planning framework has been designed as a planning tool which can predict the success of new urban rail systems, and advise how their success can be increased. Information on external factors, planning factors, operating policies, and supporting policies are the inputs to the planning framework, and the possible level of success of the urban rail system is the output. In addition, the framework has been designed to produce recommendations on how success can be enhanced. External and planning factors for an urban rail system are reviewed: if some of the factors appear to be unsuitable for the system to be successful, recommendations are made on how these factors can be improved, and hence the success of the system increased.

9.3.3 Predicting and enhancing the success of new urban rail systems

The planning framework was applied to Midland Metro and Croydon Tramlink in Britain, and the systems in Ankara, Adana, and Izmir in Turkey.

Among the new British systems, it has been shown that Croydon Tramlink will be a very successful system. The planning framework has revealed that its success can be enhanced further if certain urban planning policies are implemented to develop and improve declining areas along the system. Midland Metro has been predicted to be less successful than Croydon Tramlink although it is likely to be as successful as Manchester Metrolink. It has been observed that low local support for the system, the poor image of public transport systems in terms of personal safety, the location of the system in some under-developed and declining areas, and the fact that it does not replace an already existing public transport service may hinder success to some extent. It was recommended that operating policies, such as high frequency service, free transfers to buses, and free travel at certain times of the day, could help attract passengers to the system. Because the corridor served by the Midland Metro is only partially developed, and because there are declining areas along the system, it is also important to implement urban planning policies to improve and develop the areas in a public-transport-friendly way. This includes zoning such areas for trip attracting and generating activities and for high density residential areas, offering certain incentives to private developers to locate along the system, and locating or relocating public offices at stations which can help to develop the corridor and contribute to the patronage on the system. For these policies to be successful in declining areas, such areas need to be regenerated or redeveloped. Urban renewal projects that are well integrated with the Metro can help improve the urban area and contribute to the success of the system.

Among the new Turkish systems, the metro and light rail systems in Ankara have been predicted to be the most successful. Analysis of the actual performance of these systems has verified the prediction of the framework. The light rail systems in Adana and Izmir have been predicted to be less successful than those in Ankara. Urban planning policies have been recommended for the system in Adana in order to improve the conditions regarding the CBD and urban form. In addition, operating policies have been recommended to improve the image of the system which has low local support. For the system in Izmir, which is partially located in declining areas, urban planning policies have been recommended in order to redevelop such areas.

The policy recommendations of the framework are aimed at increasing the success of urban rail systems; however, it was observed that some of the policies may have another effect: increasing the co-ordination between transport and urban planning. Planning co-ordination has been an important focus of the study, and findings regarding this issue are discussed in detail in the next section.

9.3.4 Mechanisms for attaining co-ordination between transport and urban planning

An important focus of this study has been on exploring alternative ways of providing and sustaining co-ordination between transport and urban planning. As discussed throughout the research, local government structures were not suitable for co-ordinated planning in most of the cities observed. Fragmentation of governments and the lack of a strong metropolitan government were important factors inhibiting planning co-ordination.

Fragmentation of governments is particularly significant in American cities since they have very high numbers of municipalities; however, the study revealed that recent developments in local government in Britain had created a different type of fragmentation which affected the planning of some urban rail systems, and hence their success: centrally-appointed planning agencies that by-passed local authorities has resulted in the loss of planning co-ordination. Fragmentation of local government in both Britain and United States has become a more severe problem because of the lack of a strong metropolitan government that can provide co-ordination between local authorities.

The lack of strong metropolitan government was observed to be a very important factor that reduced the co-ordination between transport and urban planning. Particularly in Britain, where metropolitan county councils were abolished in 1985, co-ordinated planning was very difficult to attain. However, it is not possible to claim that the local government organisation in the US has been particularly advantageous. Although

American cities have a metropolitan government, they are often in the form of Councils of Governments (COGs) rather than well-established government units with a wide range of planning powers. COGs, by nature, are not powerful governments, and do not play very active roles in urban planning.

The analysis revealed that metropolitan governments in the form of well-established government units, such as the modernisation of the county government in Miami, in the US, and the establishment of regional governments by the Provincial Governments in Canada and by the co-operation of local authorities in Portland, in the US, were suitable for comprehensive and co-ordinated planning. Successful joint development projects in Miami showed that the Metro-Dade could be an effective form of government in terms of planning co-ordination, although apart from the joint development schemes, the co-ordination remained limited because of financial bottlenecks and various urban problems that had to be given priority. Another strong metropolitan government was in Vancouver, Canada: the Greater Vancouver Regional District (GVRD) provided strong co-ordination between the rail system and urban plans and projects early on in the planning of the system. However, GVRD was abolished later for several years, and therefore, the government organisation in Vancouver too, remained unsuitable for co-ordinated planning. It was remarkable that the local authorities, nevertheless, sustained their plans and continued supporting the rail investment. In addition to the case studies, the analysis of Portland MAX system, which has been used as a test system in this research, also revealed that a strong metropolitan-regional government with significant planning powers can be effective in attaining and sustaining policy co-ordination.

Although local government structures were not suitable for co-ordinated urban and transport planning in many of the cities observed, some of them succeeded in attaining and sustaining a certain level of policy co-ordination. Transport and urban planning policies, which were generally implemented to support and enhance the success of systems, were observed to have improved the co-ordination between urban and transport planning. When transport planning policies, such as integrating the urban rail system into regional planning and into existing urban projects, were implemented, they helped to improve the compatibility of the rail system with urban plans and projects. When urban planning policies, such as adapting plans to the new system, incentives of public-transport-friendly development, and joint development projects, were implemented, they improved the compatibility of the urban plans with the urban rail system. It may be expected that these policies would be implemented in cities where there already is a good level of co-ordination between urban and transport planning. Rather surprisingly, this was not the case, except in the case of Portland. In other cities, when these policies were implemented, it was either coincidental or led by a political actor; however, once they were implemented they helped attain a certain level of co-ordination, and evidence suggests that once co-ordination was achieved between planning agencies, it was very likely to be sustained.

One important conclusion of the research, therefore, was that policy formulation and implementation has to be given substantial emphasis throughout the process of developing an urban rail system. There were some policies, as discussed above, which provided co-ordination between urban and transport planning in urban areas where co-ordination was difficult to attain spontaneously. It was observed that co-ordination between transport and urban planning existed mostly in the early stages of planning an urban rail system, because the different planning agencies were involved only in these early stages of the development of the urban rail system. If effective policies to co-ordinate plans are formulated at these stages, as in the case of Vancouver, they are likely to be sustained throughout the development and operation of urban rail systems.

Another observation regarding the implementation of policies was that they were implemented more intensively and more successfully in the North American cities than in the British ones. In the American and Canadian examples, there have been many policies implemented by the local authorities or transport agencies to attract private developers to the urban rail corridor. Partnerships, in the form of joint development schemes, have also been extensively used. This is because the tradition of planning in North American local authorities is very much based on entrepreneurial planning techniques. Although it was discussed how the planning approaches of British local authorities have been transformed from regulationist techniques towards entrepreneurial ones, it seems that they have not yet adopted these techniques as successfully as their North American counterparts. The experience of Rouen tram, the only example from France, may imply that these techniques are not very common for French governments either. Analysis of Turkish urban rail systems too revealed that the local authorities in Turkey did not experiment much with urban planning policies that are aimed at attracting developers to rail corridors.

9.4 COMPARISON WITH PREVIOUS RESEARCH

The study showed that urban rail systems could be made successful when they are well supported by transport and urban planning policies. Furthermore, the study showed that systems could be successful even in American cities where urban settings are often not suitable for urban rail investment. There are systems that were built and are operated cost-effectively; there are systems which contributed to the total public transport patronage; and there are systems which had very positive impacts on urban development and land-use. None of the findings can be interpreted to suggest that rail systems are necessarily better than buses, but on the other hand, they show that rail systems can be successful when they are accompanied by supporting policies, and therefore some of the criticisms made by bus proponents, such as Gomez-Ibanez (1985) and Richmond (1998a, 1998b), are overstated.

It may be very difficult, however, to make rail systems successful in urban areas that are very much car-oriented and very hostile to public transport. Urban planning policies, which are considered in this study to be one of the main tools for enhancing success, may not be effective in such urban areas. The study showed that urban planning policies which aim to improve the urban area by using a rail system as the main instrument, have very marginal effects in urban areas that are extremely hostile to public transport and high density development. In that sense, the findings verify the arguments by Johnston et al (1988), Kain (1988) and Wachs (1993) who argue the unsuitability of rail investment in very low density Californian cities.

In addition, the findings showed that urban rail investment does not result in a reduction in traffic congestion, or improvement in air quality. Expectations that rail systems will reduce traffic congestion are indeed overestimated as some critics, such as Gomez-Ibanez (1985), Hass-Klau and Crampton (1998), and Mackett and Edwards (1998), argue. On the other hand, in none of the cities observed here, were there policies of car restriction to accompany the introduction of the urban rail system. However, there was evidence that when car parking was limited, patronage on the system and on the entire public transport systems could be increased. As a result, evidence suggests that if urban rail systems are supported with restrictions on car parking, the effects on public transport are stronger.

The aim of this research was not to help the decision-making process of whether or not to build urban rail systems. It is argued that investment in urban rail is likely to continue since there is explicit support from politicians and planners in some cities; therefore, this study provides guidelines to enhance the success of new urban rail systems that are being planned or operated. The analysis has revealed that indeed there is scope for making some systems more successful. Urban rail systems can be successful when urban plans and transport plans are well integrated into each other. This observations does not contradict Knight and Trygg (1977), Priest (1980), Skinner and Dean (1980), Miller et al (1989), Glick (1992), Walmsley and Perrett (1992), Pucher (1994), Mackett and Edwards (1996), TRB (1996a), and Cervero and Landis (1997). This study also recognises that such planning co-ordination is an exception rather than the rule, and that it is rarely achieved within the existing local government systems. Therefore, the methods of providing planning co-ordination have been considered in the study.

9.5 FUTURE RESEARCH

There are a number of key areas in which this study can be used as a basis for further research.

This study can be developed into a decision support tool for planners and politicians who are willing to invest in urban rail systems. Since the planning framework produced in this study can predict the success of new systems, it can be developed to predict how successful an urban rail system can be in particular urban areas, hence how suitable urban areas are for rail investment, and what kind of supporting planning actions would be necessary if the planners decide to proceed with investment.

Analysis of more systems and testing of the framework on new systems are likely to reveal further issues about the success of systems because they may reveal different experiences, hence different factors behind the success or failure of systems.

Comparison of North American and British experiences revealed the effects of different planning traditions on the success of urban rail systems. British planning agencies did not experience the entrepreneurial techniques very much, and they did not implement many policies that can attract the private sector to the development of urban rail corridors while North American municipalities were more successful in introducing incentives to attract private developers along the urban rail systems. A study focusing on the differences between North American and British municipalities, and their planning traditions and techniques could contribute to the urban rail planning process in Britain, and help planners employ such entrepreneurial techniques more frequently and successfully.

Local government systems in Britain and the fragmentation of planning over the past decades have been discussed in the literature thoroughly, but their implications for urban rail systems have been limited to studies on Sheffield (Lawless, 1990, 1999; Hill, 1995; Dabinett, 1999; Haywood, 1999). This study revealed that lack of support from planning agencies was a major factor inhibiting the success of urban rail systems in Britain. Further analysis can provide valuable input for the arguments regarding local government as well as urban rail system planning in Britain.

Similarly, the fragmentation of local governments in the United States and different mechanisms of metropolitan government are discussed in the literature at length. The research has revealed that neither the fragmentation of governments nor the COGs with their weak planning powers were suitable mechanisms for the urban rail planning process in American cities. Further analysis of the effects of lack of co-ordination between numerous municipalities and the effects of the lack of a powerful regional plan may provide some important inputs for local government and planning studies in the United States.

Finally, broadening the content of the analysis by including more international comparisons can further contribute to the understanding of the factors affecting the success of urban rail systems. Incorporating political differences, institutional differences, and differences in the public transport operating regimes can reveal lessons not only for the field of urban rail system planning, but for transport and urban planning in general, as well as for political sciences.

9.6 CONCLUDING REMARKS

This study has been designed as a contribution to the discussions in the literature about new urban rail systems. In the recent decades, several urban rail systems have been developed, and not all of them have been as successful and effective as expected. However, this study has shown that it is possible to make them more successful. The main product of this study is a comprehensive planning framework which addresses a large number of factors that affect the success of urban rail systems. With the help of this framework, it will be possible to formulate policies that can enhance the success of urban rail systems, and so help to develop urban rail systems as effective alternatives to the car.

REFERENCES

Allport, R.J. and J.J.G. Bamford (1998) Realising the potential of mass rapid transit systems in developing cities. Paper presented at the *8th World Conference on Transport Research*, Antwerp.

Arrington, G.B. Jr. (1995) *Beyond the field of dreams: light rail and growth management in Portland.* Portland, Oregon, Tri-Met.

Bakker, J. J. (1992) LRT lessons that can be learned from Edmonton and Calgary. *Transportation Research Record* **1361**, 39-46.

Banister, D. (1994) *Transport Planning in the UK, USA and Europe.* E&FN Spon, UK.

Banister, D. and P. Hall (1995) Summary and conclusions, in Banister, D (ed) *Transport and Urban Development*, E&FN Spon, UK.

Banister, D. and N. Lichfield (1995) The Key Issues in Transport and Urban Development, in Banister, D (ed) *Transport and Urban Development*, E&FN Spon, UK.

Batista, M. C. (1997) Interview conducted with Mria C. Batista, Principle Planner, Transit System Development, Metro-Dade Transit, Miami.

BC Transit (1996) *On track: the SkyTrain story.* BC Transit.

Bernick, M. and R. Cervero (1997) *Transit villages in the 21st Century.* McGraw-Hill.

Biehler, A. (1989) Exclusive busways versus light rail transit. *TRB Special Report 221 Light Rail Transit: new system successes at affordable prices.* Transportation Research Board, National Research Council, Washington D.C.

Bi-State Development Agency (1995) *Market Research Report: On Board Survey Summer 1995.* Program Evaluation Department, Bi-State Development Agency.

Black, A. (1993) The recent popularity of light rail transit in North America. Journal of *Planning Education and Research* **12**, 150-159.

Bottoms, G. D. (1997) Light-Rail transit developments in Western Europe. Proceedings of Seventh National Conference on Light Rail Transit, *Transportation Research Board Conference Proceedings* **8**, 3-14.

Bourne, L.S. (1999) The North American urban system: the macro-geography of uneven development, in Boal, F.W. and S.A. Royle (eds) North America: a geographical mosaic, Arnold Publichers, pp. 173-190.

Bragado, N. S. (1997) Interview conducted with Nancy Schwarz Bragado, Senior Planner, City of San Diego Planning Department Liaison, San Diego.

Brindley, T., Y. Rydin and G. Stoker (1989) *Remaking planning: the politics of urban change in the Thatcher years*, Unwin Hyman, UK.

Brindley, T., Y. Rydin and G. Stoker (1996) *Remaking planning: the politics of urban change*, second edition, Unwin Hyman, UK.

Brown, G. (1998) Interview conducted with Graham Brown, General Manager, Supertram Ltd, Sheffield.

Burness, R. (1997) Interview conducted with Rob Burness, City Planner, Sacramento County Council, Sacramento.

Bushell, (1997) *Jane's urban public transport systems 1995-1996*, Jane's Information Group Limited, Coulsdon.

Byrne, D. (1999) Tyne and Wear UDC - turning the uses inside out: active deindustrialisation and its consequences, in Imrie, R. and H. Thomas (eds) *British Urban Policy: an evaluation of the Urban Development Corporations*. London: Sage.

Cani, R. (1997) Regenerating urban centres through integrated land use and transport planning policies: lessons from the USA. PTRC 22nd European Transport Forum, *Proceedings of Seminar C: Policy, Planning, and Sustainability*, 251-261.

Cervero, R. (1994) Rail-oriented office development in California: how successful? *Transportation Quarterly* **48**, 33-44.

Cervero, R. and J. Landis (1997) Twenty Years of the Bay Area Rapid Transit System: Land-Use and Development Impacts. *Transportation Research A* **31**, 309-333.

Checkoway, B. (1985) Revitalizing an urban neighborhood: a St Louis case study, in Checkoway, B. and Patton, C.V. The metropolitan Midwest: policy problems and prospects for change, University of Illinois Press, pp 244-268.

Corso, A.W. (1983) San Diego: the anti-city, in Bernard, R.M. and B.R. Rice (eds) Sunbelt cities: politics and growth since World War II, University of Texas Press, pp 328-344.

Cullingworth, J.B. and V. Nadin (1997) *Town and country planning in the UK*. Twelfth edition. London: Routledge

Dabinett, G. and P. Ramsden (1999) Urban policy in Sheffield: regeneration, partnership and people, in Imrie, R. and H. Thomas (eds) *British Urban Policy: an evaluation of the Urban Development Corporations*. London: Sage.

Dabinett, G., T. Gore, R. Haywood and P. Lawless (1999) Transport investment and regeneration. Sheffield: 1992-1997. *Transport Policy* **6**, 123-134.

Davoudi, S., A. Gilliard, P. Healey, B. Pullen, S. Raybould, F. Robinson, D. Silcock, D. Usher, and C. Wymer (1993) *The longer term effects of the Tyne and Wear Metro.* Transport Research Laboratory, Contractor Report 357.

Deas, I., J. Peck, A. Tickell, K. Ward and M. Bradford (1999) Rescripting urban regeneration, the Mancunian way, in Imrie, R. and H. Thomas (eds) *British Urban Policy: an evaluation of the Urban Development Corporations.* London: Sage.

Department of the Environment (1990) US experience in evaluating urban regeneration, London: HMSO.

Department of the Environment and Department of Transport (1994) *Planning Policy Guidance: Transport.* PPG13.

Department of the Environment, Transport and the Regions (1998a) *A new deal for transport: better for everyone.* Transport White Paper.

Department of the Environment, Transport and the Regions (1998b) *Transport Statistics Great Britain 24th Edition.* London: HMSO.

Department of the Environment, Transport and the Regions (1999a) *Transport Statistics Great Britain 25th Edition.* London: HMSO.

Department of the Environment, Transport and the Regions (1999b) *Focus on Public Transport Great Britain 1999 Edition.* London: HMSO.

Dueker, K.J. and M. J. Bianco (1999) Light-rail-transit impacts in Portland: the first ten years. Transportation Research Record **1685**, 171-180.

Dunn, J.A (1980) Co-ordination of urban transit services: the German model. *Tranportation* **9**, 33-43.

Dunphy, R.T. (1996) New Developments in Light Rail. *Urban Land*, 37-41, 87-88.

Dunphy, R.T. (1997) Review of Recent American Light Rail Experiences. Proceedings of Seventh National Conference on Light Rail Transit, *Transportation Research Board Conference Proceedings* **8**, 104-113.

East-West Gateway Co-ordinating Council (1996) *Where we stand: the strategic assessment of the St Louis Region.* East-West Gateway Co-ordinating Council, St Louis.

ECMT (1994) *Light Rail Transit Systems.* The European Conference of Ministers of Transport (ECMT) Publication, France.

Edwards, M. and R.L. Mackett (1996) Developing new public transport systems: an irrational decision-making process. *Transport Policy* **3**, 225-239.

EGO (2000) World-wide web site of EGO, the Transport Planning and Operating Department of Municipality of Greater Ankara, at http://www.ego.gov.tr/

Environment, Transport and Regional Affairs Committee (2000) *Light Rapid Transit Systems*. House Commons, Session 1999-2000 Eight Report. The Stationary Office, Norwich.

Fainstein, S. S. And N. Fainstein (1991) Economic development policy in the US federal system under the Reagan administration, in Pickance, C. and E. Preteceille (eds) State restructuring and local power: a comparative perspective, Pinter Publichers Ltd., pp 150-170.

Fainstein, S.S. (1996) The changing world economy and urban restructuring, in Fainstein, S.S. and S. Campbell (eds) *Readings in urban theory*, Blackwell, UK.

Farrell, J. E. (1997) Interview conducted with James E. Farrell, Vice President, Infrastructure, Technology, and Environment, St Louis Regional Commerce and Growth Association, St Louis.

Federal Transit Administration (1999) *1997 National Transit Database*. World wide web site at http://www.fta.dot.gov/

Federal Transit Administration (2000) *1998 National Transit Database*. World wide web site at http://www.fta.dot.gov/

Fouracre, P.R, R.J. Allport and J.M. Thomson (1990) *The Performance and Impact of Rail Mass Transit in Developing Countries*. Transport and Road Research Laboratory, Research Report 278.

Fox, P. (1996) Tram operation in Sheffield: progress, problem and a crisis. *Light Rail Review* **7**, 63-71.

Fullerton, B. and S. Openshaw (1985) An evaluation of the Tyneside Metro, in Button, K.J. and D.E. Pitfield (eds) *International Railway Economics*. Gower Publishing Company Ltd.

Garcia, M. G. (1997) Interview conducted with Mario G. Garcia, Chief of Transit System Development Division, Metro-Dade Transit, Miami.

Gillespie, A.E. (1980) *Transport and the Inner City*. A Report Commissioned by SSRC Inner Cities Working Party, Social Science Research Council.

Glick, F. (1992) Light rail transit and effective land use planning: Portland, Sacramento, and San Diego. *Transportation Research Record* **1361**, 75-80.

Goldberg, M.A. and J. Mercer (1986) The myth of the North American City: continentalism challenged. University of British Columbia Press, Vancouver.

Gomez-Ibanez, J.A. (1985) The Dark Side to Light Rail? Experience of three new transit systems. *Journal of the American Planning Association* **51**, 337-351.

Goodwin, M., S. Duncan and S. Halford (1992) *Regulation theory, the local state and the transition of urban politics.* Centre for Urban and Regional Research, University of Sussex.

Gordon, P. and R. Willson (1984) The determinants of light-rail transit demand: an international cross-sectional comparison. *Transportation Research A* **18**, 135-140.

Great Britain Office for National Statistics (1998a) *1991 Census: key statistics for urban and rural areas.* London: HMSO.

Great Britain Office for National Statistics (1998b) Regional accounts 1996 Part 2, *Economic Trends*, no.535

GVRD (1976) *The Livable Region Strategic Plan.* Greater Vancouver Regional District, Vancouver.

GVRD (1996) *Creating our future: steps to a more livable region.* Greater Vancouver Regional District, Vancouver.

GVRD (1999) *Greater Vancouver Key Facts.* http://www.gvrd.bc.ca/go/arch/keyfacts.html

GVRD (2000) *Translink.* http://www.translink.bc.ca/

Gwilliam, K.M, C.A. Nash and P.J. Mackie (1985) Deregulating the bus industry in Britain - the case against. *Transport Reviews* **5**, 105-132.

Hague, P. (1994) South Yorkshire Supertram: achieving government funding. *Proceedings of the Light Rail '94 Conference,*ed. L. Lesley. Transport Science Limited, Liverpool, 15-20.

Hall, P. (1995) A European perspective on the spatial links between land-use, development and transport, in Banister, D. (ed) *Transport and Urban Development.* E&FN Spon, UK.

Hall, P. (1996) *Cities of tomorrow.* Blackwell, UK.

Hall, P. and C. Hass-Klau (1985) *Can rail save the city? The impacts of rail rapid transit and pedestrianisation on British and Germain cities.* Gower Publishing Company, England.

Hallman, H.W. (1977) *Small and large together: governing the metropolis.* Sage: Beverly Hills.

Hamel, P. and L. Jalbert (1991) Local power in Canada: stakes and challenges in the restructuring of the state, in Pickance, C. and E. Preteceille (eds) State restructuring and local power: a comparative perspective, Pinter Publichers Ltd., pp 171-196.

Hass-Klau, C., and G. Crampton (1998) *Light rail and complementary measures.* A report for the Department of the Environment, Transport and the Regions, by Environment and Transport Planning, UK.

Hass-Klau, C., G. Crampton, M. Weidauer, V. Deutsch (2000) *Bus or light rail: making the right choice.* Published by Environmental and Transport Planning, Brighton.

Haywood, R. (1998a) *South Yorkshire Supertram: final report on planning applications and land-use change research.* Sheffield Hallam University, School of Urban and Regional Studies.

Haywood, R. (1998b) Mind the gap: town planning and Manchester's local railway network: 1947-1996. *European Planning Studies* **6**, 187-210.

Haywood, R. (1998c) Interview conducted with Russ Haywood, Sheffield Hallam University, School of Urban and Regional Studies.

Haywood, R. (1999) South Yorkshire Supertram: its property impacts and their implications for integrated land use-transportation planning. *Planning Practice and Research* **14**, 277-299.

Healey, P., S. Cameron, S. Davoudi, S. Graham and A. Madani-Pour (eds) (1995) *Managing Cities: the new urban context*, Wiley, UK.

Hellewell, D.S. (1991) *Financing light rail: case studies.* International Union Assosication of Public Transport (UITP).

Henry, L. (1989) Ridership forecasting considerations in comparisons of light rail and motor bus modes, in Transportation Research Board, *Special Report 221: Light Rail Transit, new system successes at affordable prices*, National Research Council, Washington D.C.

Heseltine, P.M. and C. Mulley (1993) Longer-term benefits of the Tyne and Wear Metro. *Transportation Planning Systems* **1**, 47-55.

Hill, R. (1995) The Toulouse Metro and the South Yorkshire Supertram: a cross cultural comparison of light rapid transit developments in France and England. *Transport Policy* **2**, 203-216.

Holt, D. (1992) *Manchester Metrolink.* UK Light Rail Systems. Platforms Publishing Ltd., Sheffield.

Howard, D. F. (1993) *Metro: a brief introduction.* Tyne and Wear Passenger Transport Executive.

Hubbell, J. and D. Colquhoun, D. Bolger, J. Morrall (1997) Light rail transit in Calgary, 1981-1995: a retrospective review. Proceedings of Seventh National Conference on Light Rail Transit, *Transportation Research Board Conference Proceedings* **8**, 15-27.

Hughes, R. (2000) Written correspondance with Ray Hughes, former Head of Development, CENTRO (West Midlands Passenger Transport Executive).

Imrie, R. and H. Thomas (1999) *British Urban Policy: an evaluation of the Urban Development Corporations*. London: Sage.

Ito, K. (1997) Interview conducted with Kengi Ito, Planner, City of Burnaby, Vancouver.

Jacobs, B.D. (1992) *Fractured Cities: capitalism, community and empowerment in Britain and America.* Routledge, UK.

Johnson, W.C. (1997) *Urban planning and politics*. American Planning Association Press: Chicago.

Johnston, R.A., D. Sperling, M.A. DeLuchi, and S. Tracy (1988) Politics and technical uncertainty in transportation inestment analysis. *Transportation Research A* **21**, 459-475.

Kain, J.F. (1988) Choosing the wrong technology: or how to spend billions and reduce transit use. *Journal of Advanced Transportation* **21**, 197-213.

Kain, J.F. (1997) Cost-effective alternatives to Atlanta's rail rapid transit system. *Journal of Transport Economics and Policy* **31**, 25-50.

Keating, M. (1991) *Comparative urban politics: power and the city in the United States, Canada, Britain, and France*. Aldershot Elgar.

Kevill, P. (1998) Interview conducted with Paul Kevill, Director of Public Transport Planning, South Yorkshire Passenger Transport Executive (SYPTE).

Keyworth, J. (1998) Interview conducted with John Keyworth, former Director of Planning, Sheffield Development Corporation (SDC).

Khasnabis, S. (1998) Land-use and transit integration and transit use incentives. *Transportation Research Record,* **1618**, 39-47.

King, D.S. and J. Pierre (1990) (eds) *Challenges to local government*. Sage: London.

King, D.S. (1990) Economic activity and the challenge to local government, in King, D.S. and J. Pierre (eds) *Challenges to local government*. Sage: London.

Knight, R.L. (1980) The impact of rail transit on land-use: evidence and a change of perspective. *Transportation* **9**, 3-16.

Knight, R.L. and L.L. Trygg (1977) Evidence of land-use impacts of rapid transit systems. *Transportation* **6**, 231-248.

Knowles, R.D. (1994) *Manchester Metrolink impact study 1990-1994*. University of Salford, Department of Geography.

Knowles, R.D. (1996) Transport impacts of Greater Manchester's Metrolink light rail system. *Transport Geography* **4**, 1-14.

Lagerqvist, G. (1979) Residential Area Structure and Layout, in CRESSWELL, R. (ed) *Urban Planning and Public Transport.* The Construction Press, Lancester, pp.56-63.

Larwin, T. F. (1997a) San Diego's latest extension opens. *Transportation Research Board LRT News* **12** (3), 1-4.

Larwin, T. F. (1997b) Interview conducted with Thomas F. Larwin, General Manager of Metropolitan Transit Development Board, San Diego.

Lawless, P. (1990) Regeneration in Sheffield: from radical intervention to partnership, in Parkinson, M. and D. Judd (eds) *Leadership and urban regeneration.* London: Sage.

Lawless, P. (1999) Transport investment and urban regereneration in a provincial city: Sheffield, 1992-96. *Environment and Planning C: Government and Policy* **17**, 211-226.

Lees, L. (1999) The Pacific Northwest: rural backwater o urban ecotopia, in Boal, F.W. and S.A. Royle (eds) *North America: a geographical mosaic*, Arnold Publichers, pp. 239-248.

Light Rail Transit Association UK Development Group (1997) *Fact Sheet no 49: South Yorkshire Supertram - Success or Failure?* The fact sheet can be found at the world wide web: http//www.lrta.org/facts49.html

Ling, D. (1994) Manchester Metrolink: 18 months on. *The Transport Economist* **21**(2), 1-10.

Lion, B. (1997) Interview conducted with Burton Lion, Planner, City of Surrey, Vancouver.

Lloyd-Jones, T. (1996) Curitiba: Sustainability by design. *Urban Design* **57**, 26-32.

Local Government Act (1985). London: HMSO.

Logan, J.R. and T. Swanstrom (1990) Urban restructuring: a critical view. in Logan, J.R. and T. Swanstrom (eds) *Beyond the city limits.* Temple University Press, Philadelphia.

Loukaitou-Sideris, A. and T. Banerjee (2000) The Blue Line blues: why the vision of transit village may not materialize despite impressive growth in transit ridership. *Journal of Urban Design* **5**, 101-125.

Mackett, R.L. (1998) *Why are travel demand forecasts so often wrong (and does it matter)?* Paper written for presentation at the UTSG Annual Conference, held in Dublin, January 1998.

Mackett, R.L. and M. Edwards (1996) Guidelines for planning a new urban public transport system. *Proceedings of the Institution of Civil Engineers: Transport* **117**, 193-201.

Mackett, R.L. and M. Edwards (1998) The Impact of New Urban Public Transport Systems: Will the Expectations Be Met? *Transportation Research A* **32**, 231-245.

Mackie, P., J. Preston and C. Nash (1995) Bus deregulation: ten years on. *Transport Reviews* **15**, 229-251.

Magnusson, W. (1990a) Progressive politics and Canadian cities, in King, D.S. and J. Pierre (eds) *Challenges to local government*. Sage: London.

Magnusson, W. (1990b) Regeneration and quality of life in Vancouver, in Parkinson, M. and D. Judd (eds) *Leadership and urban regeneration*. London: Sage.

Martin, B. (1995) Interview conducted with Brian Martin, former managing director, MVA, for the UTOPIA project carried out by Prof Roger Mackett, Centre for Transport Studies, UCL, London.

Mercer, J. (1999) Norh American cities: the micro-geography, in Boal, F.W. and S.A. Royle (eds) North America: a geographical mosaic, Arnold Publichers, pp. 191-206.

Miller, C., D. Coomer, and R. Jameson (1989) Role and function of transit in growth management: current issues in Florida. *Transportation Research Record* **1237**, 64-76.

Mohl, R.A. (1983) Miami: the ethnic cauldron, in Bernard, R.M. and B.R. Rice (eds) Sunbelt cities: politics and growth since World War II, University of Texas Press, pp 58-99.

Moon, H. (1990) Land use around suburban transit stations. *Transportation* **17**, 67-88.

Moore, C. (1990) Displacement, partnership and privatisation: local government and urban economic regeneration in the 1980s, in King, D.S. and J. Pierre (eds) *Challenges to local government*. Sage: London.

Moore, J.E. (1994) Commentary on "The recent popularity of light rail transit in North America". *Journal of Planning Education and Research* **13**, 50-52.

Morris, W.H. (1975) Comparison of busway and light rail modes. *Special Report 161: Light rail transit*. Transportation Research Board, National Research Council, Washington D.C.

OECD (1999) world wide web site of the OECD at http://www.oecd.org

Paaswell, R.E. (1995) ISTEA: Infrastructure investment and land-use, in Banister, D. (ed) *Transport and Urban Development*, E&FN Spon, UK.

Parkinson, T. (1989) Advocacy for conventional light rail, *TRB Special Report 221 Light Rail Transit: new system successes at affordable prices*. Transportation Research Board, National Research Council, Washington D.C.

Parkinson, M. (1990) Political responses to urban restructuring: the British experience under Thatcherism. In Logan, J.R. and T. Swanstrom (eds) *Beyond the city limits*. Temple University Press, Philadelphia.

Parkinson, T. (1992) Rail transit performance. *Transportation Research Record* **1361**, 47-52.

Parkinson, T. (1997) Interview conducted with Tom Parkinson, President of Transport Consulting Ltd., Vancouver.

Pickrell, D.H. (1990) *Urban rail transit projects: forecast versus actual ridership and costs*. US Department of Transportation.

Pickrell, D.H. (1992) A Desire named Streetcar: Fantasy and fact in Rail Transit Planning. *Journal of the American Planning Association* **58**, 158-176.

Pickvance, C. (1991) The difficulty of control and the ease of structural reform: British local government in the 1980s, in Pickance, C. and E. Preteceille (eds) State restructuring and local power: a comparative perspective, Pinter Publichers Ltd., pp 48-89.

Pickvance, C. and E. Preteceille (1991) The significance of local power in theory and practice, in Pickance, C. and E. Preteceille (eds) *State restructuring and local power: a comparative perspective*, Pinter Publichers Ltd., pp 1-17.

Plescia, A. J. (1997) Interview conducted with Andrew J. Plescia, Deputy Director for Planning and Development, Capitol Area Development Authority (CADA), Sacramento.

Preteceille, E. (1990) Political paradoxes of urban restructuring: globalization of the economy and locatization of politics?, in Logan, J.R. and T. Swanstrom (eds) *Beyond the city limits*. Temple University Press, Philadelphia.

Priest, D.E. (1980) Enhancing the developmental impact of rail transit. *Transportation* **9**, 45-55.

Public Purpose (1996) *Urban Transport Fact Book 1996*. World wide web site at http://www.publicpurpose.com/

Pucher, J. (1994) Public transport developments: Canada vs The United States. *Transportation Quarterly* **48**, 65-78.

Read, M.J., J. Allport and P. Buchanan (1990) The potential for guided busways. *Traffic Engineering and Control* **31**, 580-587.

Richmond, J.E.D. (1998a) *New rail transit investments - a review: summary paper.* Taubman Centre, Kennedy School of Government, Harvard University and MIT Cooperative Mobility Research Program.

Richmond, J.E.D. (1998b) The mythical conceptions of rail transit in Los Angeles. *Journal of Architecture and Planning Research* **15**, 294-320.

Ridley, T.M. (1983) A tale of three cities. *Paper presented at the meeting of the Society of Engineers*, London, 3rd October 1983.

Robertson, K.A. (1980) The impact of transportation on central business district. *Traffic Quarterly* **34**, 523-537.

Robinson, P. (1997) Interview conducted with Pilka Robinson, General Manager of Regional Transit District, Sacramento.

Rowley, G. (1995) The Sheffield Supertram and urban redevelopment. *The East Midland Geographer* **18**, 25-38.

Scott, B. (1998) Interview conducted with Bill Scott, Business Development Manager (previously Metro Manager), Nexus, Tyne and Wear.

Schumann, J.W. (1989) What's new in North American Light Rail Transit projects? *TRB Special Report 221 Light Rail Transit: new system successes at affordable prices.* Transportation Research Board, National Research Council, Washington D.C.

Senior, M.L. (1999) The short-term transport impacts of light rail: the evidence of secondary data from Greater Manchester's Metrolink. *Transportation Planning and Technology* **22**, 149-180.

Simpson, B.J. (1987) *Planning and public transport in Great Britain, France and West Germany.* Longman Scientific and Technical, England.

Simpson, B.J. (1988) *City centre planning and public transport: case studies from Britain, West Germany and France.* An Nostrand Reinhold, UK.

Simpson, B.J. (1989) *Urban rail transit - an appraisal.* Transport and Road Research Laboratory, Contractor Report 140.

Simpson, B.J. (1994) *Urban public transport today.* E&FN Spon, UK.

Skelsey, G. (2000) Twenty years of the Tyne and Wear Metro. *Tramways & Urban Transit*, **63**, 209-211.

Skinner, R.E. and T.B. Dean (1980) Second generation US rail transit systems: prospects and perils. *Transportation* **9**, 17-32.

Smith, D.M. (1999) Atlanta: Metropolis of the new south, in Boal, F.W. and S.A. Royle (eds) *North America: a geographical mosaic*, Arnold Publichers, pp. 208-212.

Smyth, A.W. (1994) Guided bus: anything LRT can do it can do? PTRC 22nd European Transport Forum, *Proceedings of Seminar E: Public transport planning and operations*, 153-168.

Stauder, S. A. (1997) Interview conducted with Susan A. Stauder, Special Assistant for Strategic Planning, Bi-State Development Agency, St Louis.

Stepner, M. J. (1997) Interview conducted with Michael J. Stepner, City Planner, Urban Design Co-ordinator, City of San Diego, San Diego.

Stewart, J. and G. Stoker (eds) (1995) *Local government in the 1990s*. The Macmillan Press Ltd., UK.

Stott, J. (1997) Interview conducted with Joe Stott, Senior Planner, Strategic Planning Department, Greater Vancouver Regional District (GVRD), Vancouver.

Talleda, F. D. (1997) Interview conducted with Frank D. Talleda, Chief, Joint Development and Leasing Division, Metro-Dade Transit, Miami.

Taplin, M. (1997) A world of trams and urban transit. *Light Rail and Modern Tramway* **60 supplement**, 1-8.

Taplin, M. (2000) *A world of trams and urban transit - updated*, can be found at the internet, at: http//www.lrta.org

Taylor, N. (1998) *Urban planning theory since 1945*. Sage Publications, UK.

Transport Act (1985). London: HMSO.

TRB (1975) *Special Report 161: Light rail transit*. Transportation Research Board, National Research Council, Washington D.C.

TRB (1978) *Special Report 179: Glossary of urban public transportation terms*. Transportation Research Board, National Research Council, Washington D.C.

TRB (1989) *Urban public transportation glossary*. Transportation Research Board, National Research Council, Washington D.C.

TRB (1996a) *Transit and Urban Form*. Transit Cooperative Reserach Program Report 16, Transportation Research Board, National Academy Press, Washington D.C.

TRB (1996b) *Integration of Light Rail Transit into City Streets*. Transit Cooperative Reserach Program Report 17, Transportation Research Board, National Academy Press, Washington D.C.

TRB (1997a) *The role of transit in creating livable metropolitan communities*. Transit Cooperative Reserach Program Report 22, Transportation Research Board, National Academy Press, Washington D.C.

TRB (1997b) *Building transit ridership: an exploration of transit's market share and the public policies that influence it.* Transit Cooperative Reserach Program Report 27, Transportation Research Board, National Academy Press, Washington D.C.

Tyne and Wear Passenger Transport Executive (1985) *The Metro Report: the impact of metro and public transport integration in Tyne and Wear.*

Tyson, W.J. (1995) Bus deregulation - the planning dilemma. *Transport Reviews* **15**, 307-313.

US Census Bureau (1999) world wide web site at http://www.census.gov/

Vuchic, V.R (1975) Place of light rail transit in the family of transit modes, in TRB *Special Report 161: Light Rail Transit.* Transportation Research Board, National Research Council, Washington D.C.

Wachs, M. (1977) Transportation policy in the Eighties. *Transportation* **6**, 103-120.

Wachs, M. (1993) Learning from Los Angeles: transport, urban form, and air quality. *Transportation* **20**, 329-354.

Wahl, D.J. and L.A. Humiston (1992) San Diego Trolley: performance trends. *Transportation Research Record* **1361**, 278-286.

Wallace, I. (1999) Manufacturing in North America, in Boal, F.W. and S.A. Royle (eds) North America: a geographical mosaic, Arnold Publichers, pp. 141-154.

Walmsley, D. and G. Gardner (1993) The economic effects of public transport. Paper for *the International Workshop on Environment, Traffic and Urban Planning*, Delft.

Walmsley, D. and K. Perrett (1992) *The Effects of Rapid Transit on Public Transport and Urban Development.* London:HMSO.

Ward, L. (1997) Interview conducted with Larry Ward, President and CEO, British Columbia Rapid Transit Company Ltd, Vancouver.

Warren, W.D. (1995) Why success in St Louis? *Transport News* **180**, 22-26.

Wegener, M. (1995) Accessibility and Development Impacts, in BANISTER, D. (ed) *Transport and Urban Development.* E&FN Spon, London.

White, P. (1995) Deregulation of local bus services in Great Britain: an introductory review. *Transport Reviews* **15**, 185-209.

Wilson, D. and C. Game (1994) *Local government in the United Kingdom.* Macmillan, UK.

Wolman, H. (1990) The Reagan urban policy and its impacts, in King, D.S. and J. Pierre (eds) *Challenges to local government.* Sage: London.

Wolman, H., and M. Goldsmith (1992) *Urban politics and policy: a comparative approach.* Blackwell, UK.

Wood, C. (1994) Bringing back the tram: learning from the Continent. PTRC 22nd European Transport Forum, *Proceedings of Seminar E: Public transport planning and operations*, 141-152.

Young, A.P. (1989) Development and Implementation of Greater Manchester's Light Rail Transit. *TRB Special Report 221 Light Rail Transit: new system successes at affordable prices.* Transportation Research Board, National Research Council, Washington D.C.

Young, A. P. (1997) Light-Rail development in Great Britain. Proceedings of Seventh National Conference on Light Rail Transit, *Transportation Research Board Conference Proceedings* **8**, 36-45.

Zimmerman, J.F. (1980) The government of metropolitan areas: United States, in Rowat, D.C. (ed) *International handbook on local government reorganization*, Aldwych Press, London, pp. 45-60.

APPENDIX: NEW GENERATION URBAN RAIL SYSTEMS IN NORTH AMERICA AND EUROPE

New urban rail systems in North America and Europe have been used in the study in order to compare the performance of the case study systems and reference systems with the average performance of other urban rail systems that operate in the same country or continent. The subject of the research is new generation urban rail systems; therefore, systems built after 1970 have been included. In addition, Toronto and Montreal metros, which opened in 1954 and 1966, respectively, have been included in order to be able to compare the performance of Vancouver SkyTrain with that of Canadian metros, because that system has the characteristics of both metro and light rail, and no metros opened in Canada more recently than those in Toronto and Montreal. As a result, all metro, light rail, and tram systems since 1970 have been included, excluding very small ones (those smaller than 5 km) and those that have been upgraded from pre-existing tramway services.

The following two tables present data on these systems. The first table shows the annual performance data of the systems. The second table presents the annual performance indicators calculated from this data, together with the country and continent averages.

It is important to note that, the averages calculated, throughout the study, are not the arithmetic averages of the indicators, but calculated by dividing the sum of one annual performance figure for a country by the sum of another figure for that country. For example, the average vehicle load of the US metros is not the arithmetic average of the vehicle load values of the US metro systems, but calculated by dividing the sum of the annual passenger kilometres of all US metros by the sum of their annual vehicle kilometres.

Urban rail systems in North America and Europe: annual performance data

Country	System in:	Type of system	Opening year	Route length (km)	Patronage	Passenger kilometres	Vehicle kilometres	Number of staff	Capital cost (£) (in year 1998)	Operating cost (£)	Fare revenue (£)
USA	Atlanta	metro	1984	62.20	77,802,000	786,639,351	35,693,988	1,354	3,678,558,900	63,464,548	20,491,979
	Baltimore	metro	1983	24.95	12,833,591	108,191,103	6,807,338	441	1,136,248,800	22,181,255	6,480,000
	Los Angeles	metro	1993	17.90	12,269,205	38,818,069	2,649,979	276	1,278,319,580	21,100,656	714,565
	Miami	metro	1984	33.00	13,482,522	167,873,647	9,773,574	422	1,058,285,200	32,305,716	9,393,914
	S. Francisco	metro	1972	130.00	80,256,779	1,589,806,372	88,957,558	2,916	N/A	190,061,990	N/A
	Washington	metro	1976	144.00	213,044,900	1,733,666,007	72,086,453	4,062	7,371,832,000	240,875,975	N/A
	Baltimore	LRT	1992	48.92	7,046,126	77,271,343	3,869,299	301	502,564,400	15,088,952	3,564,000
	Buffalo	LRT	1984	10.00	7,213,821	26,173,567	1,436,822	140	708,417,200	9,167,418	N/A
	Dallas	LRT	1996	32.00	10,949,625	94,826,543	4,189,818	275	352,503,700	18,170,825	N/A
	Denver	LRT	1994	8.50	4,806,895	21,012,993	1,095,047	93	141,412,600	5,259,601	N/A
	Los Angeles	LRT	1990	57.00	23,883,883	274,487,196	7,294,434	479	717,415,600	33,744,589	3,343,131
	Miami	LRT	1986	7.10	4,052,881	6,563,631	1,442,239	129	313,912,500	9,549,111	N/A
	Portland	LRT	1986	24.20	11,846,048	101,879,964	2,753,763	362	309,078,300	14,599,387	2,594,825
	Sacramento	LRT	1987	29.50	8,074,880	63,455,255	2,989,738	153	164,725,600	9,712,813	3,833,516
	San Diego	LRT	1981	80.40	22,969,209	245,843,464	9,965,987	415	609,386,928	17,380,206	10,135,632
	San Jose	LRT	1987	32.00	6,910,000	53,103,017	3,345,520	269	526,550,400	17,212,056	3,258,638
	St Louis	LRT	1993	29.00	14,560,291	154,368,029	4,142,871	159	259,738,400	12,614,402	5,391,582
CANADA	Montreal	metro	1966	65.00	197,000,000	N/A	N/A	N/A	N/A	N/A	N/A
	Toronto	metro	1954	55.00	153,000,000	N/A	N/A	N/A	N/A	N/A	N/A
	Calgary	LRT	1981	29.30	41,600,000	74,440,000	2,800,000	152	642,953,100	5,937,931	N/A
	Edmonton	LRT	1978	13.70	10,184,400	N/A	N/A	N/A	361,576,800	N/A	N/A
	Scarborough	ALRT	1985	6.50	3,500,000	N/A	N/A	N/A	184,485,620	N/A	N/A
	Vancouver	ALRT	1986	28.90	41,599,299	690,861,780	15,216,500	349	843,383,500	21,884,096	7,932,696
FRANCE	Grenoble	LRT	1987	18.00	22,600,000	N/A	N/A	N/A	247,049,700	N/A	N/A
	Nantes	LRT	1985	26.00	25,800,000	N/A	N/A	N/A	270,539,700	N/A	N/A
	Paris	LRT	1992	9.10	17,000,000	N/A	N/A	N/A	67,052,300	N/A	N/A
	Strasbourg	LRT	1994	11.40	17,800,000	N/A	N/A	N/A	207,068,280	N/A	N/A
	Rouen	LRT	1994	15.10	14,000,000	N/A	1,430,000	135	256,166,900	24,175,095	8,944,785

(cont.) Country	System in:	Type of system	Opening year	Route length (km)	Patronage	Passenger kilometres	Vehicle kilometres	Number of staff	Capital cost (£) (in year 1998)	Operating cost (£)	Fare revenue (£)
NETHERLANDS	Utrecht	LRT	1983	21.50	8,800,000	N/A	N/A	N/A	N/A	N/A	N/A
SPAIN	Valencia	LRT	1988	12.60	19,600,000	N/A	N/A	N/A	N/A	N/A	N/A
SWITZERLAND	Lausanne	LRT	1991	7.80	7,200,000	N/A	N/A	N/A	70,050,011	N/A	N/A
UK	Docklands	LRT	1987	28.00	16,700,000	102,900,000	2,400,000	N/A	775,743,352	N/A	12,000,000
	Tyne/Wear	LRT	1980	59.00	35,000,000	248,800,000	4,800,000	656	533,216,600	26,900,000	20,700,000
	Manchester	LRT	1992	31.00	13,800,000	88,200,000	3,200,000	200	175,659,500	9,200,000	13,200,000
	Sheffield	LRT	1994	29.00	9,200,000	34,000,000	2,700,000	250	271,074,308	9,000,000	4,700,000

Sources: US data for patronage, passenger kilometres, vehicle kilometres, number of staff, and operating cost are from Federal Transit Administration (2000); US data for fare revenue is provided by the operators of the systems and some are obtained from Hass-Klau and Crampton (1998); UK data for patronage, passenger kilometres, vehicle kilometres, and fare revenue are from Department of the Environment, Transport and the Regions (1999a); patronage data for the Canadian and Continental European systems are from Bushell (1997) except for Calgary, Vancouver, and Rouen; for Calgary, Vancouver, and Rouen all data are provided by the operators of the systems.

Sources of capital cost data are as follows: documents sent by system operators or given during interviews for the systems in Atlanta, Baltimore, Los Angeles, Portland, San Jose, Miami, Sacramento, San Diego, St Louis, Calgary, Edmonton, Vancouver, Rouen, Tyne and Wear, Manchester, and Sheffield; information provided by the Public Purpose (1996) for Washington, Buffalo, Dallas, and Denver; Walmsley and Perrett (1992) for Scarborough; former correspondence with the operators by Prof. Roger Mackett, Centre for Transport Studies, UCL, for Lausanne; Bottoms (1997) for Paris and Strasbourg; Hellewell (1991) and Walmsley and Perrett (1992) for Grenoble and Nantes; Young (1997) for Docklands.

Notes: Data are for the year 1998 except for the following cases: patronage data for Canadian and Continental European systems are for the year 1995 except for Calgary, Vancouver, and Rouen; passenger kilometres data for Vancouver and Calgary are for the year 1990; operating cost data for Manchester is based on its performance in 1996 reported by Knowles (1996); all fare revenue data are for the year 1997.

Route length of the systems are those in year 1998.

Capital costs represent the value of investment in the year 1998 in English Sterling. All currency conversions are made with the Purchasing Power Parity index provided by the OECD (1999). Investments for extensions to the systems after 1998 are not included.

Urban rail systems in North America and Europe: annual performance indicators and country and continent averages

Country	System in:	Type of system	Passengers / route km	Vehicle load (passenger km / vehicle km)	Passengers / vehicle kilometres	Passengers / member of staff	Annualised capital cost / passenger (£)	Operating cost / passenger (£)	Fare revenue / passenger (£)	Farebox recovery ratio (%)
USA	Atlanta	metro	1,250,836	22	2.18	57,461	3.89	0.82	0.23	32
	Baltimore	metro	514,372	16	1.89	29,101	7.28	1.73	0.51	31
	Los Angeles	metro	685,430	15	4.63	44,454	8.57	1.72	0.06	4
	Miami	metro	408,561	17	1.38	31,949	6.46	2.40	0.67	29
	S. Francisco	metro	617,360	18	0.90	27,523	N/A	2.37	N/A	N/A
	Washington	metro	1,479,478	24	2.96	52,448	2.85	1.13	N/A	N/A
	US metro average		**994,270**	**21**	**1.90**	**43,257**	**3.63**	**1.39**	**0.29**	**27**
	Baltimore	LRT	144,034	20	1.82	23,409	5.87	2.14	0.53	28
	Buffalo	LRT	721,382	18	5.02	51,527	8.08	1.27	N/A	N/A
	Dallas	LRT	342,176	23	2.61	39,817	2.65	1.66	N/A	N/A
	Denver	LRT	565,517	19	4.39	51,687	2.42	1.09	N/A	N/A
	Los Angeles	LRT	419,015	38	3.27	49,862	2.47	1.41	0.15	7
	Miami	LRT	570,828	5	2.81	31,418	6.37	2.36	N/A	N/A
	Portland	LRT	489,506	37	4.30	32,724	2.15	1.23	0.25	20
	Sacramento	LRT	273,725	21	2.70	52,777	1.68	1.20	0.49	40
	San Diego	LRT	285,687	25	2.30	55,347	2.18	0.76	0.55	68
	San Jose	LRT	215,938	16	2.07	25,688	6.27	2.49	0.48	20
	St Louis	LRT	502,079	37	3.51	91,574	1.47	0.87	0.37	46
	US LRT average		**341,068**	**26**	**2.88**	**44,077**	**3.10**	**1.33**	**0.37**	**25**
CANADA	Montreal	metro	3,030,769	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Toronto	metro	2,781,818	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Canada metro average		**2,916,667**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
	Calgary	LRT	1,419,765	27	14.86	273,684	1.27	0.14	N/A	N/A
	Edmonton	LRT	743,387	N/A	N/A	N/A	2.92	N/A	N/A	N/A
	Scarborough	ALRT	538,462	N/A	N/A	N/A	4.34	N/A	N/A	N/A
	Vancouver	ALRT	1,439,422	45	1.70	119,196	1.67	0.53	0.19	38
	Canada LRT average		**1,241,096**	**N/A**	**N/A**	**N/A**	**1.73**	**N/A**	**N/A**	**N/A**

(cont.) Country	System in:	Type of system	Passengers / route km	Vehicle load (passenger km / vehicle km)	Passengers / vehicle kilometres	Passengers / member of staff	Annualised capital cost / passenger (£)	Operating cost / passenger (£)	Fare revenue / passenger (£)	Farebox recovery ratio (%)
FRANCE	Grenoble	LRT	1,255,556	N/A	N/A	N/A	0.90	N/A	N/A	N/A
	Nantes	LRT	992,308	N/A	N/A	N/A	0.86	N/A	N/A	N/A
	Paris	LRT	1,868,132	N/A	N/A	N/A	0.32	N/A	N/A	N/A
	Strasbourg	LRT	1,561,404	N/A	N/A	N/A	0.96	N/A	N/A	N/A
	Rouen	LRT	927,152	N/A	9.79	103,704	1.50	1.73	0.64	37
	France LRT average		**1,221,106**	**N/A**	**N/A**	**N/A**	**0.89**	**N/A**	**N/A**	**N/A**
NETHERLANDS	Utrecht	LRT	409,302	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SPAIN	Valencia	LRT	1,555,556	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SWITZERLAND	Lausanne	LRT	923,077	N/A	N/A	N/A	0.80	N/A	N/A	N/A
UK	Docklands	LRT	596,429	43	6.96	N/A	3.04	N/A	0.72	N/A
	Tyne/Wear	LRT	593,220	52	7.29	53,354	1.25	0.76	0.58	77
	Manchester	LRT	445,161	28	4.31	69,000	1.05	0.69	0.99	143
	Sheffield	LRT	317,241	13	3.41	36,800	2.42	1.15	0.60	52
	Europe LRT average		**772,812**	**N/A**	**N/A**	**N/A**	**1.29**	**N/A**	**N/A**	**N/A**

Sources: See the sources under the previous table.

Notes: Vehicle load is the average number of passengers in each vehicle, and calculated by dividing passenger kilometres by vehicle kilometres.

Annualised capital cost is calculated by discounting the capital cost (in year 1998) over 30 years at 8%.

There is a free fare zone in the city centre in Calgary, which is likely to generate short trips on the system. Indeed, the average trip length, which can be calculated from the information given in the tables, is extremely low compared to other systems. This may explain the very low operating cost per passenger trip for Calgary C-Train. If unit cost per passenger km is compared, differences are less marked: for example, this value is £0.03 for Vancouver SkyTrain; £0.08 for Calgary C-Train; £0.10 for Manchester Metrolink; and £0.11 for Tyne and Wear Metro.